

## Systematic and field keys to the families, genera and described species of Southern African Anuran tadpoles\*

With preliminary inclusion of certain undescribed and inadequately described tadpoles

by

D. E. van Dijk

### SYNOPSIS

Tadpoles provide excellent characters for the identification of Anuran species, but have not yet received adequate taxonomic study. Attention is drawn to the unsatisfactory nature of some previous descriptions of tadpoles occurring in Southern Africa, and to some of the difficulties involved. A list of features useful for descriptions of tadpoles is given, especially of the details of structure of the tadpole mouth, and the terms *rostradont* and *keratodont* are coined for certain cornifications forming part of the masticatory apparatus. These features are embodied in a framework of alternatives useful in descriptions.

Keys are given to the families, subfamilies, genera and species of Southern African tadpoles as far as these are known. A diagrammatic field key is also provided. Only 6 species of Anura, other than *Bufo* spp. and *Breviceps* spp., found within this region are too insufficiently known to be included. Diagnoses of hitherto undescribed tadpoles are given for the following species: *Xenopus muelleri*, *Cacosternum namaquense*, *Cacosternum nanum*, *Ptychadena subpunctata*, *Pt. vernayi*? *Rana vertebralis*, *Strongylopus hymenopus*. The general literature on tadpoles is briefly surveyed, and a detailed systematic list of references is given.

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Keys and illustrations, except for *Ptychadena* and *Strongylopus* material since added, were presented in a paper read at the Durban Congress of the South African Association for the Advancement of Science in July, 1963, and all material on which the paper was based has been demonstrated or loaned on request since. Cyclostyled copies of the keys were circulated to people known to be interested and a field key to the genera appeared in the Limnological Society of Southern Africa News Letter in 1964. Those keys have been completely revised and are superseded by the present keys. The bibliography has been expanded, notably with the aid of the much appreciated facilities of the Niedersächsische Staats- und Universitätsbibliothek, Göttingen.

## INTRODUCTION

During the course of a study of the development of the cloacal region of certain Anura (van Dijk, 1959), it was found necessary, due to high mortality at metamorphosis, to supplement the tadpole material obtained from eggs with metamorphosing tadpoles collected in the field, and this resulted in attempts being made to ascertain what reliable criteria could be used for identifying the species required. It was found possible to construct keys to the families, genera and many species of Southern African Anura when at metamorphosing age. Tadpoles that had been described were reinvestigated and an attempt made at describing those not previously studied. Sufficient progress has been made during the past three years for a preliminary account to be desirable. The present paper is such an account.

The tadpoles have been named by identifying the adults into which they developed, or which produced them, according to the conclusions on synonymy of Poynton in his unpublished thesis and in Poynton (1964), except where there has been very good reason to do otherwise, in which case attention is drawn to the relevant circumstances. Recourse to the services of Dr. J. C. Poynton for the identification or confirmation of the identification of adult and juvenile Anura has often been made and this is gratefully acknowledged. I am also indebted to Dr. Poynton for collecting spawn of *Ptychadena taenioscelis* and *Phrynomerus bifasciatus* and for making other material in his possession available to me. I am indebted to Mr. D. G. Broadley of Umtali Museum for collecting tadpoles of *Rana vertebralis* and *Strongylopus (Rana) wageri*, to Mr. W. J. Lawson of Durban Museum for collecting tadpoles of *Chiromantis xerampelina* and *Phrynomerus bifasciatus*, to Mr. C. Tinley for collecting tadpoles identified as *Strongylopus hymenopus*, and to Mr. K. Tinley for collecting tadpoles of *Chiromantis xerampelina* and *Hyperolius tuberilinguis* for me and for assisting me in collecting, for which I also thank Mr. W. J. Lawson and many others. The hospitality of Mr. Ian Garland is most gratefully acknowledged, and thanks are also due to those responsible for making available to me the material in the collections of the South African Museum, Cape Town, the McGregor Museum, Kimberley, the Transvaal Museum, Pretoria, and the Zoology Department, University of Stellenbosch.

## TECHNIQUES AND PROCEDURE

## Examination of Collections

Owing to the uncertainty of identification of tadpoles in collections in South African Museums and Universities, these collections were found to be useful mainly for permitting examination of additional specimens of tadpole species already collected and identified. The material from which descriptions were originally made, for instance by Power and by Hewitt, are no longer available for study, although such descriptions were made at museums. Such material as has been preserved has often been found to be in rather unsatisfactory condition; some series contained more than one species under a single label. Existing collections have nonetheless been invaluable, particularly where permission has been obtained to make permanent preparations of specimens from series. It is hoped that there will be collections of tadpoles at museums comparable with the collections of adult Anura

in the future, and some of the material from the present study will be housed at the Natal Museum as a contribution to this end.

#### Scope of Literature referred to

An attempt has been made to accumulate all the existing literature on Southern African Anura which deals with the life-histories, breeding habits, -sites and -seasons, as well as that giving descriptions of the eggs or tadpoles, not only of Southern African Anura, but also of African species. In the present study references to papers which include comment falling within the scope outlined above are listed in chronological order without analysing their contents. An analytic study of the literature is intended at a future date.

#### Collecting, Rearing and Preserving

Descriptions of tadpoles at a particular stage, easily recognisable in all species, seemed desirable in a comparative study of tadpoles. The stage chosen was Stage 55 according to the Normal Table of *Xenopus laevis* (Faber and Nieuwkoop, 1955); at this stage the hind-limb bud begins to show five toes. Collections of tadpoles were sorted into the various types present, the various types were reared and some tadpoles of each type were sampled as close to Stage 55 as possible. It was sometimes necessary, with rare material, to examine living tadpoles at this stage and then allow them to metamorphose so that the juveniles could be identified. Mating adult *Anura* were collected where possible and the eggs produced were allowed to develop as far as they would in the laboratory. Occasionally eggs were squeezed from a gravid female (this is possible in many species without injury to the animal) into a suspension of ground testis of a male, inter-specific crosses sometimes also being performed in this manner. Inter-specific crosses were also attempted by separating a pair in amplexus and offering them mates of another species, this also proving successful. All rearing of tadpoles proved difficult as collecting trips often resulted in tadpoles being left unattended for days or weeks in the laboratory. Where particular species were being sought, care was taken to collect in areas where other species of the same genus were unlikely to be present. Tadpoles were preserved in 4% formaldehyde, or, after fixation in Bouin's fluid, in 70% alcohol. Permanent preparations of mouth parts, nostril regions, spiracles, and other diagnostic features were made by excision, staining with Light Green (saturated in 96% alcohol), clearing (after dehydration) in Methyl Benzoate or Xylene, and mounting on microscopic slides.

#### CONCERNING THE DESCRIPTION OF TADPOLES

Certain descriptions of tadpoles, such as the descriptions of the tadpole of *Microbatrachella* by Hewitt (1925, pp. 423-425), of *Breviceps* by de Villiers (1929, pp. 142-151), of *Schismaderma* (*Bufo*) *carens*, *Hylambates* (*Kassina*) *senegalensis*, *Phrynobatrachus natalensis* and *Phrynomerus bifasciatus* by Power (1926a, pp. 115-117; 1926a, pp. 107-111; 1927a, pp. 237-239; and 1926a, pp. 112-115) and *Phrynomerus bifasciatus* by Wager (1926, pp. 170-174, under the name *Rappia marmorata*) have included most of the features which prove to be diagnostic when a comparative study of tadpoles is made. Other descriptions, although detailed and accurate in most respects, do not deal with the diagnostic features;

such a description is that given by Wager (1926, pp. 164-169) of *Chiromantis xerampelina* tadpoles, since the position of the vent and the position of the eyes in relation to the width of the head is not given, and the oral papillae are represented as forming an uninterrupted row ventrally, although there is in fact a gap at the chin, i.e. a mental gap. Still other descriptions, such as the descriptions of *Bufo* tadpoles other than the tadpoles of *Schismaderma* (*Bufo*) *carens* and *Bufo rosei*, contain the diagnostic features of the genus, but not the species, as a comparative study would have shown. In many descriptions no reference is made to earlier work on the same species or genus although quite good descriptions already existed. Data from earlier descriptions are sometimes repeated without reference to the earlier work being made; when new data are also presented this can lead to the impression that the data from the earlier work are being confirmed. It is unfortunate that original observations have appeared in popular and semi-popular articles (Rose, 1929 and 1962; Hewitt, 1937; Fitzsimons, 1947; and numerous articles of Wager) often amongst previously published data.

The scant attention given to tadpoles may be illustrated by the descriptions of *Strongylopus* (*Rana*) *fasciatus*. Rose (1926, p. 434) stated: "Tadpole long and narrow, with yellow vertebral stripe". Three years later Rose (1929, p. 18) wrote: "The tadpole, long and thin, may be recognised by the bright stripe that is present even at this early stage." No particular stage is referred to and "this early stage" must be taken to refer merely to the tadpole condition. A further eight years elapsed before Hewitt (1937, p. 96) gave a description which included the diagnostic features of the genus as well as a feature found only in some species of the genus: "The tadpole reaches a large size, length 2 inches, and is generally pale; tail deeply webbed, and the web extends far forwards over the body above; jaws very powerful and entirely black, the lower one deep; tooth rows not very strong." The description of the jaws applies to the genus *Strongylopus*; the description of the tail fin differentiates *S. fasciatus* from *S. grayi*, *S. wageri* and *S. hymenopus*. Fitzsimons (1947, p. 34) adds that transverse stripes develop early: "Die paddavissies, wat oor 2 duim lank word, is ietwat skraal in bou en kan maklik herken word deur die uitgebreide ontwikkeling van die swemvliese en die kenmerkende dwars strepe wat in 'n betreklike vroeë stadium verskyn." Another example which may be mentioned is the descriptions of *Arthroleptis* development, the development of three species having been described without any reference having been made to whether spiracles are absent, whether the mouth shows any tadpole features, or to the position of the vent relative to the tail.

A particular difficulty in describing tadpoles is that not only must the adult to which the tadpole is referred be correctly identified, but also it must be certain that the tadpole is referred to the correct adult form. Thus Wager (1926, pp. 170-174) correctly identified some juvenile specimens as *Rappia marmorata* (i.e. *Hyperolius marmoratus*), but the tadpoles he described under this name were in fact tadpoles of another genus, viz. *Phrynomerus*, belonging to a different family; more recently there was confusion by Guibé and Lamotte (1958, pp. 266-267 and 269) of the tadpoles of *Hylambates* (*Phlyctimantis*) *leonardi* (? = *Leptopelis*) and *Chiromantis rufescens* with one another. (cf. the corrections in Wager, 1929, p. 125, and Guibé and Lamotte, 1958, Errata).

To these difficulties must be added another category, which has scarcely ever been considered when describing tadpoles; this is the question of variation, whether phenotypic

or the result of regeneration. Thus a decrease in the height of the tail fin has been noticed in tadpoles of a genus in which the tail is normally deep (*Hylambates*), when kept in shallow aquaria, and the possibility of the tip of the tail of a tadpole (often an important feature) being abnormal as a result of being a regenerate must be borne in mind.

#### FEATURES USED IN DESCRIBING TADPOLES

The features which may conveniently be used when describing tadpoles are set out below. It is necessary to define some of the terms which have been used, in particular those terms which have been coined.

**Oral Disc and Papillae:** a fleshy disc bordering the mouth and bearing papillae.

**Rostral and Mental:** the terms rostral (pertaining to the snout) and mental (pertaining to the chin) are used in connexion with the oral disc and papillae to represent the anterior or dorsal and the posterior or ventral limits (or directions) respectively.

**Rostral Gap:** a gap in the oral papillae and oral disc rostrally.

**Mental Gap:** a gap in the oral papillae mentally, the oral disc not being greatly reduced, unlike the rostral gap.

**Oral Angle:** the lines at each side, along which the oral disc folds, are referred to as the oral angles.

**Infra-angular and Supra-angular:** the oral angles serve as useful landmarks on the oral disc, dividing it into infra-angular and supra-angular portions.

**Rostrodonts:** the keratinizations (cornifications) which form the so-called "beak", or upper and lower "beaks", or "jaw", or upper and lower "jaws" or "mandibles", etc., are referred to as *rostrodonts* from the rostral cartilages on which they are borne; the *suprarostront* is borne on the suprarostral cartilage and the *infrarostront* on the infrarostral cartilage.

**Keratodonts:** the minute keratinizations occurring in rows are referred to as keratodonts (κέρας—horn, ὀδούς—tooth), as the term horny teeth has been applied not only to these structures, but also to serrations of the rostrodonts and to other non-homologous structures, and labial has been used to refer to infra-angular rows only as well as for both supra-angular and infra-angular rows.

**Mental Protuberance and Labral Scallop:** the mouth may be similar to that of an adult, with a protuberance on the lower jaw at the mental symphysis, or a projection (scallop) downwards from each side of the upper jaw, or neither.

**Nostril Size and Internarial Distance:** the size of a nostril is conveniently expressed by relating its transverse width to the distance between the nostrils. Since the distance between nostrils is usually, possibly always, greater than the width of the nostril, it is convenient to divide the nostril width into the internarial distance. This ratio is referred to for brevity as the *internarial distance*. There is a tendency for relatively larger nostrils, as measured against other structures, to be relatively closer together, and this then enhances the value of a small *internarial distance* as a measure of large nostrils.

**Extranarial Proportion:** the transverse position of the nostrils is measured by referring to the

proportion of the width of the head at the level of the nostrils which lies beyond the nostrils. This is referred to as the *extranarial proportion*.

**Extra-ocular Proportion:** the transverse position of the eyes is measured by referring to the proportion of the width of the head at the level of the eyes which lies beyond the eyes. This is referred to as the *extra-ocular proportion*.

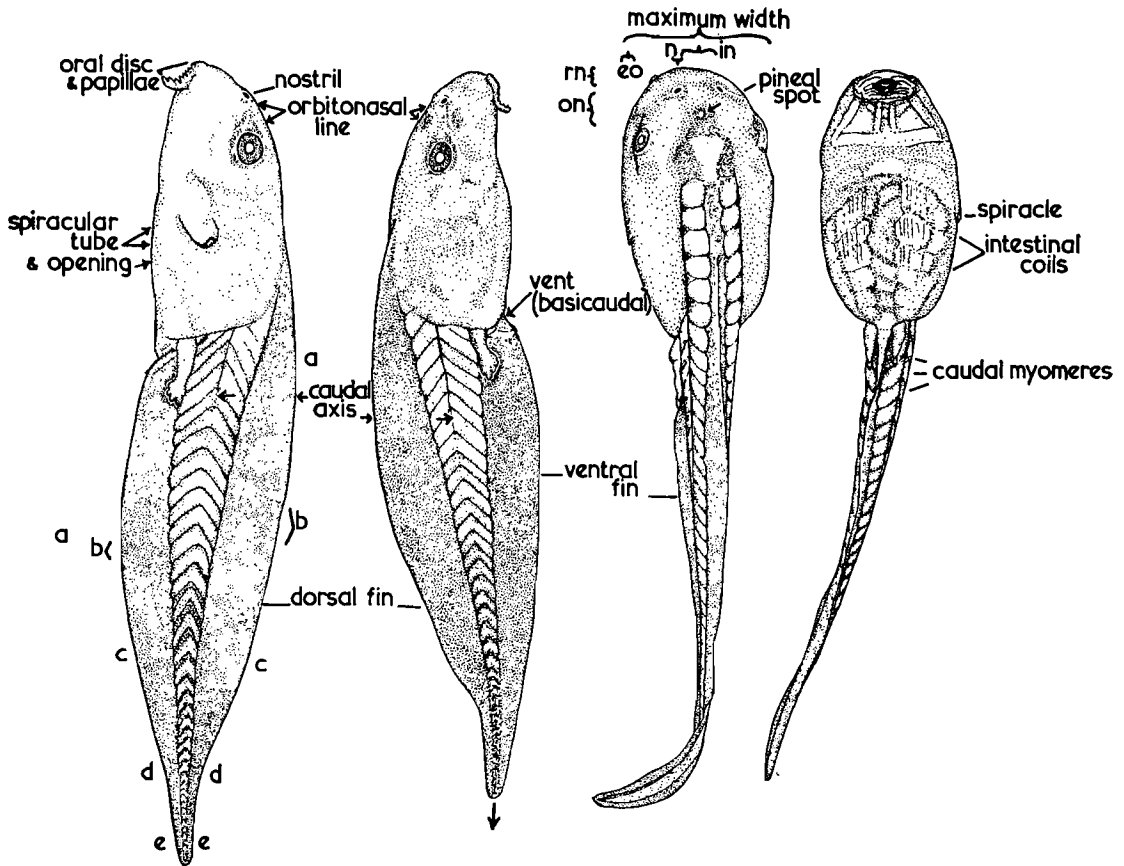


Fig. 1: *Externalia of a Tadpole*. Based on two specimens of *Cacosternum boettgeri* from Pietermaritzburg, Natal, the ventral and dextral views from one specimen and the dorsal and sinistral views from the other.

The measurements and ratios illustrated on the specimen in dorsal view are as follows:

**Extra-ocular Proportion:** represented by *eo* (*extra-ocular distance*) divided by width at the level of the eyes (which is the same as the *maximum width* in this case). The specimen has been tilted so that an extra-ocular measurement could be indicated, the eyes actually being lateral in this species and the extra-ocular measurement therefore being zero.

**Relative Anteroposterior Positions of Nostrils and Eyes:** represented by relating *rn* (*rostronasal distance*) and *on* (*orbitonasal distance*).

**Internarial Distance:** represented as the ratio of *in* (*internarial distance*) to *n* (*nostril transverse width*).

In the sinistral view significant points on the tail dorsally and ventrally are represented by *a* to *e*.

*a* represents the points of maximum height and depth relative to the trunk.

*b* represents the points of maximum width of dorsal and ventral fins.

*c* represents the points of maximum ratio of dorsal and ventral fins to the corresponding caudal muscles.

*d* and *e* represent points of inflexion, *d* from convex anteriorly to concave posteriorly, and *e* from concave anteriorly to convex posteriorly.

**Relative Anteroposterior Positions of Nostrils and Eyes:** the relative positions of nostrils and eyes anteroposteriorly may be expressed by relating the distance from the tip of the snout to the nostrils (*rostronasal distance*) to the distance from the posterior margins of the nostrils to the front margins of the eyes (*orbitonasal distance*). These distances are measured as projections along the midline.

**Relative Transverse Positions of Nostrils and Eyes:** the relative positions of nostrils and eyes transversely may be expressed by relating the transverse distance between the nostrils, or between the lateral margins of the nostrils (i.e. including the nostrils), to the transverse distance between the eyes or between the lateral margins of the eyes (i.e. including the eyes).

**Orbitonasal Line:** a groove or line, most easily seen when unpigmented, between each nostril and the corresponding eye.

**Umbraculum and Ocular- or Epidermal Elygium:** a projection of the iris of the eye into, or over, the pupil is known as an *umbraculum*. The pupil may be shaded by a pigmented layer arising from the margin of the iris *distal* to the pupil or by a pigmented layer in the skin above the eye, these pigmented layers being difficult to distinguish from one another and therefore best referred to by a single term, *elygium* (ηλύγη—shade), the former being then an *ocular elygium* and the latter an *epidermal elygium*.

**Pineal Spot:** an unpigmented or differentially pigmented middorsal spot over the epiphyseal region of the brain.

**Number and Site of Spiracles:** when paired the spiracles are long slits on either side of the abdomen; when single the spiracle may be midventral (medial) or ventrolateral or lateral (sinistral).

**Vent:** the cloacal aperture is referred to for brevity as the vent. (The term anus is not permissible for several reasons.)

**Vent Position:** the vent may open in the margin of the ventral fin medially, or the opening may involve the margin, but lie dextral to it, or the vent may be more or less remote from the margin of the fin and dextral. The term *basicaudal* is used to denote that the vent (or one margin thereof) abuts on the abdomen at the base of the tail, as opposed to a *caudal* position remote from the abdomen.

**Tail Axis:** a line along the middle of the caudal muscles, i.e. along the groove between epaxial and hypaxial portions of the muscles.

**Tail Curvature:** if the tail axis is straight the tail is referred to as *euthyoursal* (ευθύς—straight, οὐρα—tail as of fish); if the tail axis curves upwards posteriorly the tail is referred to as *anaoursal* (ἀνα—up); if the tail axis curves downwards posteriorly the tail is referred to as *kataoursal* (κατα—down). (The terms heterocercal and hypocercal are unfortunately only applicable to tail fins with lobes.)

**Tip of Tail:** the degree of roundness or pointedness of the tip of the tail may be expressed quantitatively by measuring the angle between a chord in the penultimate 1/10th of the tail and a chord in the terminal 1/10th. Such measurements can be made ventrally and dorsally. An angle of 10° or less would indicate a distinctly pointed tail. Another quantitative

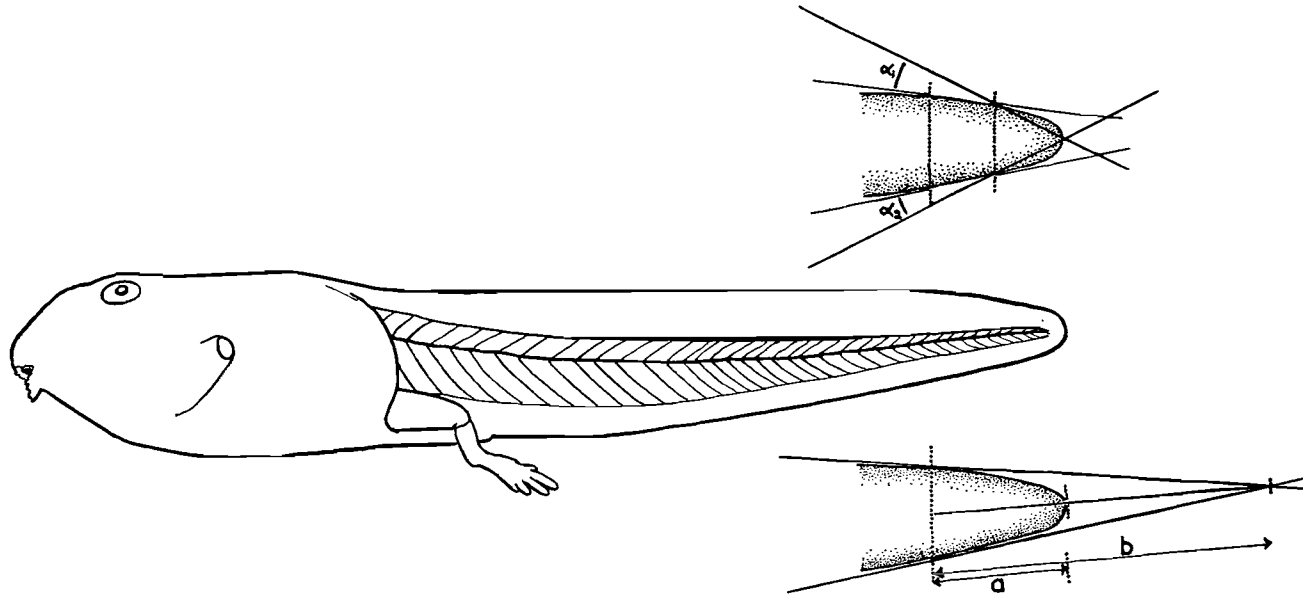


Fig. 2: Quantitative Expressions relating to the Tip of the Tail of a Tadpole: Based on a specimen of *Strongylopus grayi* from Karkloof, Natal, this species having been chosen because the tail tip is neither obviously rounded or obviously pointed to the exclusion of the other alternative. Above is shown the Penultimate 1/10 / Ultimate 1/10 Chord Angle measurement. Below is shown the Terminal 1/5 / Terminal 1/5 Tangent Triangle Ratio. The chord angles  $\alpha_1$  (dorsal) and  $\alpha_2$  (ventral) are approximately  $18^\circ$  and  $160^\circ$ . in the specimen. The terminal/terminal tangent triangle ratio  $b/a$  is approximately  $7/16$ , i.e. 0.44, in the specimen.



estimate may be obtained by measuring the terminal 1/5th of the tail and comparing this measurement with the distance from the beginning of the terminal 1/5th to the point of intersection of the tangents drawn 1/5th from the tip. A ratio

$$\frac{\text{Length of terminal 1/5th of tail}}{\text{Length of median of terminal 1/5th tangent triangle}}$$

of more than 0.5 would indicate a tendency to pointedness.

#### FRAME-WORK OF ALTERNATIVES, RATIOS AND SPECIAL FEATURES USEFUL IN DESCRIPTIONS

##### **Mouth**

*Position:* Terminal; subterminal; ventral.

*Shape:* Round aperture; horizontal slit; etc.

*Size:* Width in relation to maximum width of head and trunk, to internarial distance or interorbital distance.

*Features other than Position, Shape and Size:* Features of lips; features of buccal and pharyngeal papillae.

##### **Oral Disc**

*Position:* Terminal; subterminal, dorsally visible; subterminal, not dorsally visible; ventral; absent.

*Size:* Large, i.e.  $\frac{2}{3}$  head width or more; small, i.e.  $\frac{1}{3}$  head width or less; medium-sized: ratio to other measures as for mouth.

*Shape:* Peculiarities of shape other than those mentioned in connexion with the lateral margins and gaps in the marginal row of oral papillae.

*Lateral Margins:* Margin trans-angular, unindented; margin trans-angular, indented; margin intra-angular (margin divided by an angular cleft).

##### **Oral Papillae**

*Extent of Marginal Row:* Marginal row circumoral; marginal row with rostral gap; marginal row with rostral and mental gaps. Where rostral gap or rostral and mental gaps present, the width of the gap/s relative to the width of the oral disc, rostradont/s, keratodont rows.

*Nature of Marginal Row:* Marginal row single; marginal row double; marginal row multiple. papillae of marginal row well developed (margin papilliferous); papillae of marginal row poorly developed (margin scalloped).

*Extramarginal Papillae:* Extramarginal papillae absent; extramarginal papillae present. Where extramarginal papillae are present, their arrangement, whether in a row or rows or otherwise grouped or singly, variations in size, etc.

*Intramarginal Papillae:* Intramarginal papillae absent; intramarginal papillae present. Where intramarginal papillae are present, their arrangement, whether in a row or rows or otherwise grouped or singly, numbers which are infra-angular, numbers which are supra-angular, continuity of infra-angular and supra-angular papillae or otherwise, nature of intra-angular intramarginal oral papillae.

## Rostrodonts

### *Suprarostrodont*

*Shape of Surface:* Without inflexions: with lateral inflexions (i.e. concave laterally changing to convex medially): with medial inflexion (i.e. convex paramedially changing to concave medially): with lateral inflexions and medial inflexion. Where inflexions are absent, whether uniformly curved, or medially more curved (e.g. medially ridged), or medially less curved. Where inflexions are present, the relative widths and relative degrees of curvature on either side of the inflexion/s, and the changes in degree of curvature near the inflexion/s.

*Shape of Edge (at bases of serrations if present):* As for shape of surface.

*Serrations:* Extent of serrations along the margin. Size of serrations in relation to width of rostrum, e.g. 0.01 etc. Shape, i.e. whether wider than long, longer than wide, sharp, blunt, etc., whether normal to the margin or parallel to the longitudinal axis of the body, etc.

*Keratinization and Pigmentation:* Entirely keratinized and pigmented: pigmented and heavily keratinized along marginal  $\frac{1}{3}$  etc.: width of marginal pigmentation compared to its breadth.

### *Infrarostrodont*

*Shape:* Wider than deep: deeper than wide. Relative curvature laterally and medially, both of surface and edge; other features of surface and edge as for suprarostrodont.

*Serrations:* Extent of serrations along the margin. Size of serrations in relation to width of rostrum, e.g. 0.01 etc. Shape, i.e. whether wider than long, longer than wide, sharp, blunt etc., whether normal to the margin or parallel to the longitudinal axis of the body, etc.

*Keratinization and Pigmentation:* Entirely keratinized and pigmented: pigmented and heavily keratinized along marginal  $\frac{1}{3}$  etc.: width of marginal pigmentation compared to its breadth.

**Additional Keratinizations:** Keratinized regions other than the rostrum absent: keratinized regions other than the rostrum present. Where such keratinized regions are present, their position and nature.

## Keratodonts

*Nature of Individual Keratodonts:* Simple (unidenticulate): compound (multidenticulate): complex (with serrations in more than one plane or of more than one type): length relative to breadth: length of free portion relative to base, etc.: shape, tip rounded or pointed etc.

*Supra-angular Keratodonts:* Supra-angular keratodonts absent: supra-angular keratodonts present. Where supra-angular keratodonts are present the number of uninterrupted (continuous) rows, the number of interrupted rows and the relative sizes of the interruptions, whether the adoral (proximal) row is well-developed or rudimentary, the degree of curvature of the rows, etc.: chord lengths of rows relative to one another, rows of infra-angular keratodonts and rostrum etc.

*Infra-angular Keratodonts:* Infra-angular keratodonts absent: infra-angular keratodonts

present. Where infra-angular keratodonts are present the number of uninterrupted (continuous) rows, the number of interrupted rows, length of aboral (distal, mental) row relative to the row proximal to it and to the width (transverse) of the infrarostrodont, the relationship of the mental row to the mental gap in the oral papillae if this is present, the degree of curvature of the rows, etc.

### Nostrils

*Shape:* Round: oval.

*Margin:* Margin with (medial) projection: margin without inflexions. Margin with raised rim: margin without raised rim.

*Level of Aperture:* Nostril raised: nostril level with general surface: nostril in a depression: nostril in a depression at the end of the grooved orbitonasal line.

*Direction of Aperture:* Nostrils open dorsally: nostril opens laterally: nostril opens anteriorly: nostril opens partly in one of these directions partly in another: nostril opens partly in all three directions.

*Nasal Passage:* Visible from above: visible from the lateral aspect: visible from in front: visible from a combination of these directions.

*Distance between Nostrils:*  $\frac{\text{Internarial Distance}}{\text{Nostril Width}}$  gives a ratio which may be significant.

Lateral margins of nostrils within the medial margins of the eyes: lateral margins of nostrils beyond the lateral margins of the eyes.

*Extranarial Proportion:*  $\frac{\text{Width of head minus Distance between lateral margins of nostrils}}{\text{Distance between lateral margins of nostrils}}$  gives a ratio which may be significant.

*Longitudinal Position in relation to the Eyes:*  $\frac{\text{Rostronasal distance}}{\text{Orbitonasal distance}}$  (measured anteroposteriorly, i.e. not obliquely) gives a ratio which may be significant.

*Pigmentation in the region of the Nostrils:* Pigmentation around the nostrils greater than the surroundings: pigmentation around the nostrils less than the surroundings: pigmentation around the nostrils not distinctive. Pigmentation around the nostrils extends into the nostrils: pigmentation around the nostrils does not extend into the nostrils.

### Eyes

*Extra-ocular Proportion:*  $\frac{\text{Width of head minus Distance between lateral limits of eyes}}{\text{Distance between lateral limits of eyes}}$  gives a ratio which may be significant. Where the extra-ocular proportion is zero (i.e. eyes lateral) whether the eyes are visible from the ventral aspect or not visible from the ventral aspect.

*Size of Eye:* Size of Eye (or of Iris) relative to rostrorobital distance or length of head and trunk.

*Features of the Eyes:* Any distinctive feature of the eyes, e.g. umbraculum or elygium.

*Orbitonasal Line:* Not distinct: visible as an unpigmented line: visible as a groove: visible as an unpigmented groove.

*Pineal Spot*: Not distinct: visible as an unpigmented spot: visible as a spot with light pigment (iridiophores).

### **Spiracle**

*Number*: Absent: paired: single.

*Position in Relation to the Midline*: On either side of the midline (in the case of paired spiracles): midventral: sinistral, visible from dorsal aspect: sinistral, not visible from dorsal aspect.

*Position Anteroposteriorly*:  $\frac{\text{Distance from rostrum to centre of spiracular opening}}{\text{Distance from rostrum to posterior limits of trunk}}$  gives posterior displacement along trunk.

$\frac{\text{Distance from posterior limits of trunk to centre of spiracular opening}}{\text{Distance from centre of spiracular opening to tip of tail}}$  gives posterior displacement along tail.

*Spiracular Tube*: Spiracular tube visible (a considerable portion of the connexion between the gill chambers and the spiracular opening visible): spiracular tube not visible.

*Spiracular Opening*: Spiracular opening raised: spiracular opening not raised (medial edge of opening level with the surface of the body). Spiracular opening visible laterally: spiracular opening not visible laterally. Spiracular opening constricted (distinctly narrower than distal portion of spiracular tube): spiracular opening not constricted. Spiracular opening round: spiracular opening oval, etc.

*Direction of Terminal Part of Spiracular Tube and of Opening*: Dorsally: posterodorsally: dorsoposteriorly: posteriorly: ventroposteriorly: posteroventrally: combinations of these directions where the direction of the distal part of the spiracular tube and of the opening differs.

*Other Features of the Spiracle*: Any distinctive features such as scalloping of the edge of the spiracular opening, overlapping of the medial wall of the opening by the lateral wall, etc.

### **Vent**

*Position Anteroposteriorly*: Caudal: abdominal (basicaudal).

*Form of Aperture*: Permanently rounded: subject to folding.

*Position Relative to the Midline*: Median and marginal (opening at the margin of the ventral fin): median and infraventromarginal (the proctodaeal tube dependent from the ventral fin): dextral and marginal (the medioventral margin of the vent continuous with the margin of the fin): dextral and trans-marginal, the proctodaeal tube originating on the left side, traversing the ventral margin of the fin and opening to the right of this: dextral and supramarginal (basidextral) (not involved in the ventral margin of the ventral fin).

*Direction of Aperture*: Posterad: ventroposterad: posteroventrad: ventrad: combinations of these directions with laterad or mediad.

*Length of Proctodaeal Tube and Width of Vent*: Length of proctodaeal tube and width (and length) of vent relative to neighbouring structures, where this is characteristic.

## Tail

*Length:*  $\frac{\text{Length of tail}}{\text{Length of head and trunk}}$

*Height:*  $\frac{\text{Height of tail}}{\text{Height of trunk}}$ . Position of maximum height relative to the trunk (base of tail) and the tip of the tail. Position of the highest and lowest points relative to the trunk (base of tail) and the tip of the tail.

*Shape of Tip:* Tip of tail pointed: tip of tail rounded. Degree of pointedness or roundedness as measured by the angle between a chord in the penultimate 1/10th and a chord in the terminal 1/10th of the tail, or by the ratio  $\frac{\text{Length of terminal 1/5th of tail}}{\text{Length of median of terminal 1/5th tangent triangle}}$  (see above, under Terminology).

*Height of Fins:* Position of maximum depth of the dorsal and of the ventral fin relative to the trunk (base of tail) and the tip of the tail. Ratio of the maximum depth of the dorsal and of the ventral fin to the corresponding heights of the caudal muscles. Position, relative to the trunk (base of tail) and the tip of the tail, of the point where the ratio between the depth of the dorsal fin and the corresponding height of the caudal muscles is greatest, and of the point where the ratio between the depth of the ventral fin and the corresponding height of the caudal muscles is greatest. Maximum ratio of the depth of the dorsal fin and of the ventral fin to the corresponding heights of the caudal muscles.

*Features of the Origins of the Fins:* Dorsal fin originates in a fleshy crest on the trunk: ventral fin originates in a fleshy crest on the abdomen: dorsal and ventral fins originate in fleshy crests. Peculiarities in the points of origin of the fins, etc.

*Features of the Shape of the Fins:* Position of points of inflexion, maxima or minima in the curves of the margins of the tail fins relative to the trunk (base of tail) and of the tip of the tail, etc.

*Pigmentation Patterns of the Tail:* Hyaline: mottled: cloudy (dusky): solidly pigmented. Pigment black: pigment brown: pigment red: pigment white: combinations of these, etc. Differential pigmentation of posterior or anterior  $\frac{1}{3}$ ,  $\frac{1}{4}$  etc. Pigmented axial line (middle of caudal muscles), epaxial line (along epaxial muscles), hypaxial line (along hypaxial muscles), dorsal marginal line, ventral marginal line, or combinations of these, etc.

*Features of the Caudal Muscles:* Height at the base of the tail relative to the height of the trunk. Basal region of the caudal muscles (i.e. anterior region) obscured by connective tissue giving the appearance of a higher region of muscles anteriorly, etc.

*Axis:* Axis of the tail straight (i.e. tadpole is euthyroual): axis of the tail turns upwards posteriorly (i.e. tadpole is anaoural): axis of the tail turns downwards posteriorly (i.e. tadpole is kataoural). Axis of tail when extrapolated forwards passes dorsal, through or ventral to, the eye, nostril, oral disc, spiracle etc. Where the extrapolated axis passes dorsal or ventral to a particular reference point, the width of the eye, for example, may be used to measure the distance dorsally or ventrally.

## Development of Hind Limbs

*Skin Folds Associated with the Hind Limbs:* Hind limbs develop exposed on the posterior

surface of the trunk: hind limbs develop dorsal to a ventral flap of skin which houses the proctodaeal tube: hind limbs develop each surrounded by a fold of skin, etc.

*Features of the Hind Limbs:* Digging spur develops on the foot, and the stage at which this occurs: discs develop on the toes, and the stage at which this is distinct: etc.

*Other Features:* e.g. Region of head anterior to eyes ventrally unpigmented and transparent: region around the eyes unpigmented: epidermal elygium present above each eye: etc.

Most of the details in the foregoing frame-work would be used if diagnoses were being given of the tadpoles of the species of Anura of which tadpoles are known. In the following keys, however, for the sake of simplicity as few of these details have been used as is practicable. The keys represent differential diagnoses, and the emphasis is placed on characters which help to separate species, other characters being ignored. Characters which alone

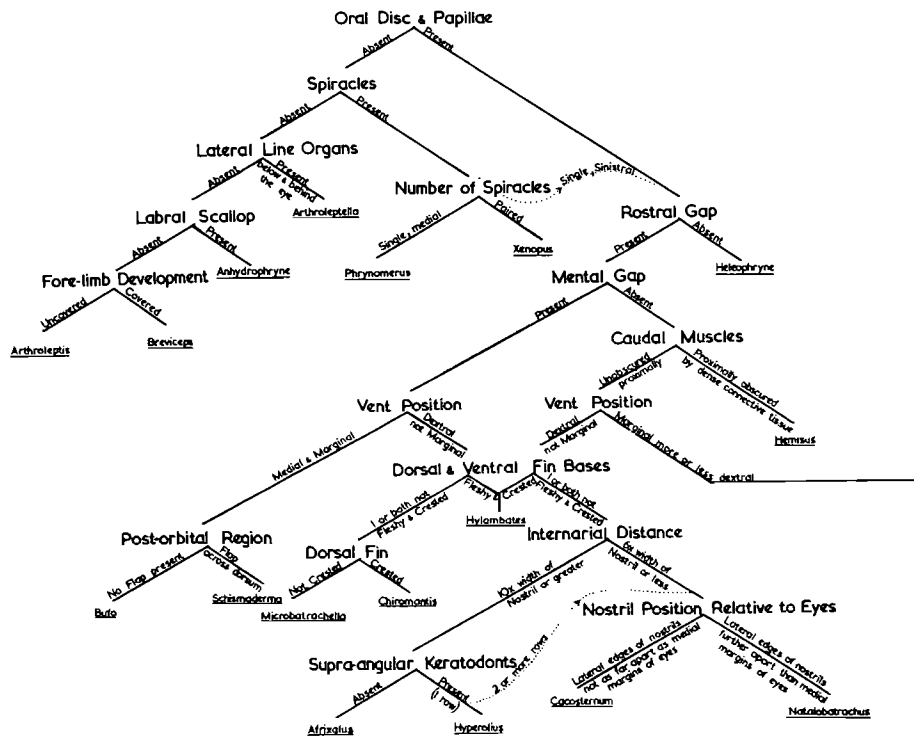


Fig. 4

are sufficient for differential diagnosis have been set in italics, the remaining characters being additional rather than essential. Where differential diagnosis is not yet possible, the species between which it is necessary to find differences have been set down. This does not imply that nothing is known about these tadpoles; it means that what is known may be common to the species, i.e. the known features may be generic characters. Often one species is poorly known and the specific characters of one or more better known species may have been described or be capable of description, but these characters cannot be recognized as specific until all the species have been adequately described.

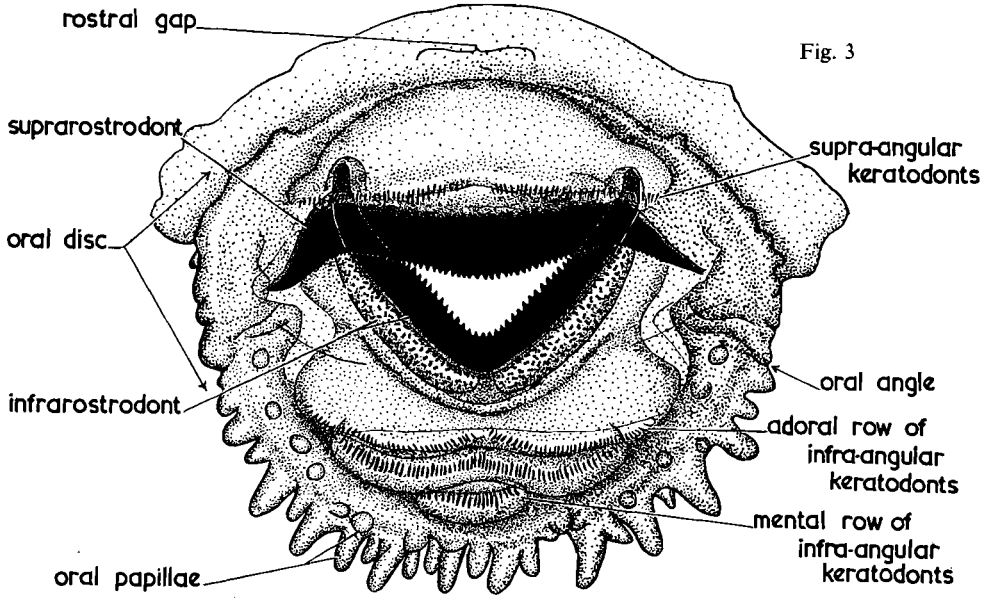
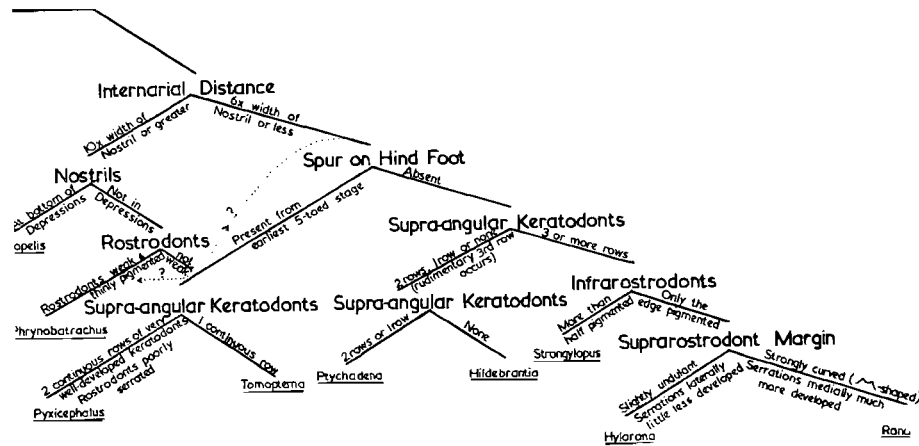


Fig. 3



## KEY TO SOUTHERN AFRICAN TADPOLES OF STAGES 50-56

## A. Families

1. *Mouth a straight or evenly curved terminal horizontal slit approximately  $\frac{3}{4}$  the width of the dorsoventrally flattened head, the oral margin without papillae except for tentacles typically present at the oral angles.* Keratodonts and supra- and infra-rostrodonts absent, but tail well-developed and the tadpole aquatic. Atrial openings two in number, ventral, postero-medially elongated slits. Vent median, opening in the deep ventral fin downwards and somewhat backwards . . . . . **Pipidae**  
 — Mouth bears oral papillae, and usually bears keratodonts and rostrodonts, and there is one atrial opening situated on the left side . . . . . 2  
 — Mouth bears a single median projection (a fold of the lower lip), and there is one atrial opening situated midventrally . . . . . **Microhylidae (Phrynomerus)**  
 — Mouth non-functional, the development encapsular, no atrial opening . . . . . 4
2. *Oral papillae present, interrupted dorsally by a broad rostral gap, and ventrally by a broad mental gap approximately half the width of the oral disc, these papillae typically arranged in a single row dorsal and ventral to each oral angle continuous across a notch at the oral angle, and with a few ( $\pm 3$  on either side) or no papillae within oral disc. Typically two rows of supra-angular, and three rows of infra-angular, keratodonts. Vent more or less median and situated in the ventral margin of the ventral fin. Nostrils typically relatively large, close to one another and closer to the eyes than to the tip of the snout. Eggs typically black at the animal pole and laid in strings of several hundred . . . . . **Bufonidae**  
 — Oral papillae form a continuous supra-angular multiple row and a continuous infra-angular multiple row, rostral and mental gaps thus being absent . . . . . 3  
 — Supra-angular oral papillae interrupted dorsally by a broad rostral gap, infra-angular oral papillae either uninterrupted ventrally, or if (rarely) a mental gap is present (usually narrow) the vent is dextral and not associated with the ventral margin of the ventral fin . . . . . 4*
3. *More than two uninterrupted rows of supra-angular keratodonts, and more than ten rows of infra-angular keratodonts.* Oral disc forming a sucker almost as wide as head. Vent opens midventrally at the tip of the ventral flap which covers the hind-limbs ventrally in the young stages and the bases of hind limbs in older stages . . . . . **Leptodactylidae**  
 — Not as above . . . . . 4
4. *Oral papillae rostrodonts, and usually keratodonts, present; OR, oral papillae, rostrodonts and keratodonts absent, mouth non-functional, development encapsular and taking place out of water, either on moss or under vegetation or just beneath the surface of the ground, not deep or at the end of a tunnel. Sensory line organs visible in the head region or upper lip with a scallop on each side or tail never as much as  $\frac{2}{3}$  as long as the head and trunk . . . . . **Ranidae**  
 — Oral papillae, rostrodonts and keratodonts absent, development encapsular and in a burrow . . . . . **Microhylidae (Breviceps)***



## B. Subfamilies

*Pipidae*

As for Pipidae . . . . . **Xenopinae**

*Bufo*nidae

As for Bufonidae . . . . . **Bufo**ninae

*Leptodactylidae*

As for Leptodactylidae . . . . . **Heleophry**ninae

*Microhylidae*

As for Microhylidae . . . . . **Brevicipit**inae

*Ranidae*

1. Rostrodonts, and usually keratodonts, present; development aquatic . . . . . 2
- Rostrodonts and keratodonts absent; development encapsular on moss and sensory line organs visible in head region or just beneath the surface of the ground and upper lip has a scallop on each side . . . **Phrynobatrachinae** (*Arthroleptella*, *Anhydrophyrne*)
- Rostrodonts and keratodonts absent; development encapsular under vegetation and sensory lines and labral scallops absent . . . . . **Arthrolept**inae
2. Vent dextral and entirely dorsal to the ventral margin of the ventral fin; margin of vent not continuous with ventral margin of the fin . . . . . 3
- Vent dextral or median, reaching the ventral margin of the ventral fin; margin of vent continuous with the ventral margin of the fin . . . . . 6
3. One row of supra-angular keratodonts, or supra-angular keratodonts absent. . . . .
- . . . . . **Hyperol**inae excluding *Leptopelis*
- Two or more rows of supra-angular keratodonts present . . . . . 4
4. Mental gap in oral papillae present. Dorsal fin raised to a high crest about  $\frac{1}{3}$  along the tail, the crest being well above the level of the trunk . . . . . **Rhacophor**inae
- Mental gap in oral papillae usually absent, where it is present the dorsal fin has no prominent crest extending above the level of the trunk . . . . . 5
5. Anterior  $\pm \frac{2}{3}$  of tail muscles obscured by opaque connective tissue which extends dorsally and ventrally beyond muscles, giving the appearance of a thicker region of muscles followed behind by a thin region (actual muscles). Hind limbs develop in a fold of skin which obscures them, except for their tips, up to the toe-bud stage. Papillae approximately 4x as long and twice as broad as the ordinary papillae present outside the oral disc ventral to a double row of infra-angular papillae, there being typically 3 on each side, with about 3 papillae slightly bigger than the ordinary ones between the two groups . . . . . **Hemis**inae
- Tail muscles not obscured by connective tissue anteriorly. Hind limbs develop on the surface of the body, not in a fold. Large papillae outside the oral disc absent . . . . .
- . . . . . **Phrynobatrachinae** (*Microbatrachella*, *Cacosternum*, *Natalobatrachus*)
6. Distance between nostrils greater than 10x nostril width (nostrils relatively small and wide apart). Nostrils lie in depressions at the ends of grooves which lead to the eyes. Typically two rows of oral papillae along the whole margin of the oral disc, which is continuous across the oral angles without being sharply divided into supra-

- and infra-angular portions . . . . . **Hyperolinae** (*Leptopelis*)
- Distance between nostrils usually less than 6x nostril width (nostrils usually relatively large and close together). Nostrils typically not depressed, often rimmed, orbitonasal line usually not grooved . . . . . 7
7. Distance between nostrils approximately 10x nostril width, nostrils not depressed, orbitonasal line not grooved. One supra-angular row of keratodonts present, sometimes together with a second vestigial row. Two infra-angular rows of keratodonts present. Rostrodonts delicate, with very thin pigmented region, and finely denticulated . . . . . **Phrynobatrachinae** (*Phrynobatrachus*)
- Not as above in all respects . . . . . **Raninae**

### C. Genera

#### *Pipidae*

Xenopinae (with characters as for subfamily) . . . . . **Xenopus**

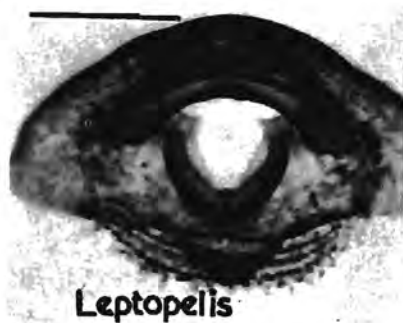
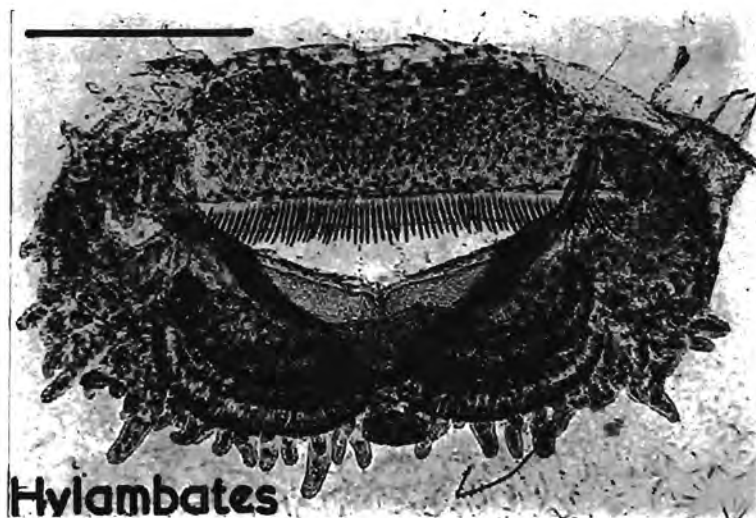
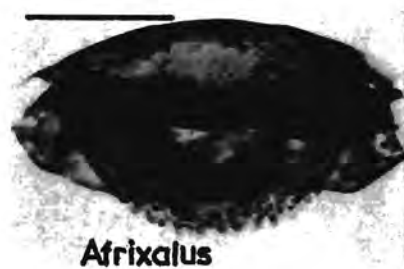
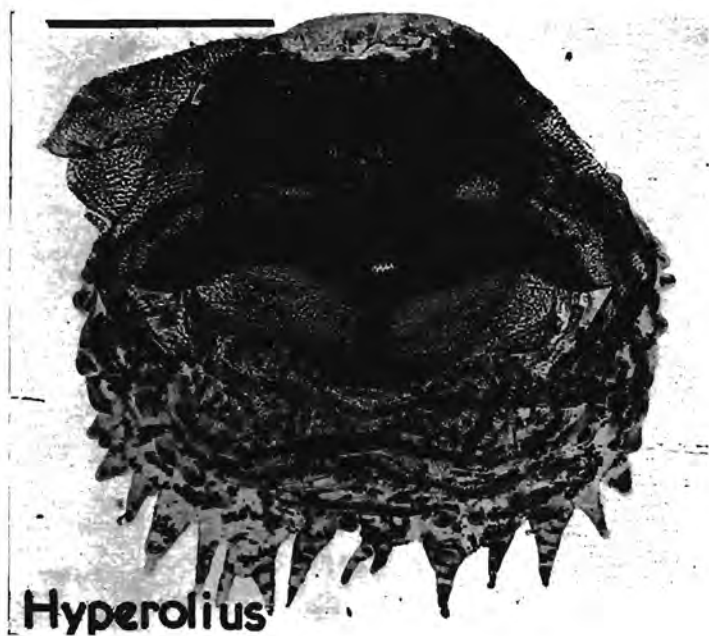
#### *Bufonidae*

Bufoninae (with characters as for subfamily) . . . . . **Bufo** (and *Schismaderma*)

#### *Leptodactylidae*

Heleophryinae (with characters as for subfamily) . . . . . **Heleophryne**





*Microhylidae*

## Brevicipitinae

1. *Development on land in a burrow* . . . . . **Breviceps**  
 — *Development aquatic* . . . . . **Phrynomerus**

*Ranidae*

## Hyperoliinae

1. *Interrupted row/s of supra-angular keratodonts present in addition to an uninterrupted row* . . . . . **Leptopelis**  
 — *One row of supra-angular keratodonts or none* . . . . . 2  
 2. *Rostrodonts pigmented along edge, not extensively. Suprarostrodont not a uniformly curved, uniformly wide band. Dorsal fin does not originate in a prominent fleshy crest* . . . . . 3  
 — *Rostrodonts greatly developed, heavily keratinized and extensively pigmented. Suprarostrodont a broad band without inflexions. Dorsal fin originates in a prominent fleshy crest* . . . . . **Hylambates** (incl. **Kassina**)  
 3. *One row of supra-angular keratodonts* . . . . . **Hyperolius**  
 — *No supra-angular keratodonts* . . . . . **Afraxalus**

## Phrynobatrachinae

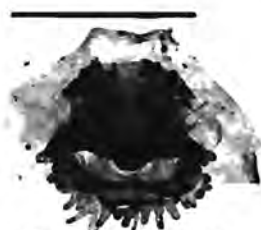
1. *Rostrodonts and keratodonts present* . . . . . 2  
 — *Rostrodonts and keratodonts absent* . . . . . 5  
 2. *Two or more rows of supra-angular keratodonts. Vent not involved in ventral margin of ventral fin* . . . . . 3  
 — *One row of supra-angular keratodonts (second vestigial row sometimes present?) Vent involved in margin of ventral fin* . . . . . **Phrynobatrachus**  
 3. *Mental gap in oral papillae absent* . . . . . 4  
 — *Small mental gap in oral papillae present* . . . . . **Microbatrachella**  
 4. *Distance between lateral edges of nostrils less than distance between medial margins of eyes* . . . . . **Cacosternum**  
 — *Distance between medial edges of nostrils greater than distance between medial limits of eyes* . . . . . **Natalobatrachus**  
 5. *Sensory line organs visible in head region; development takes place on damp moss* . . . . . **Arthroleptella**  
 — *Sensory line organs not visible. Upper lip bears a scallop on each side. Development takes place in a chamber just below the surface of the ground* . . . . . **Anhydrophryne**  
     *Rhacophorinae (with characters as for subfamily)* . . . . . **Chiromantis**  
     *Arthroleptinae (with characters as for subfamily)* . . . . . **Arthroleptis**  
     *Hemisinae (with characters as for subfamily)* . . . . . **Hemisus**  
     *Raninae*



**Chiromantis**



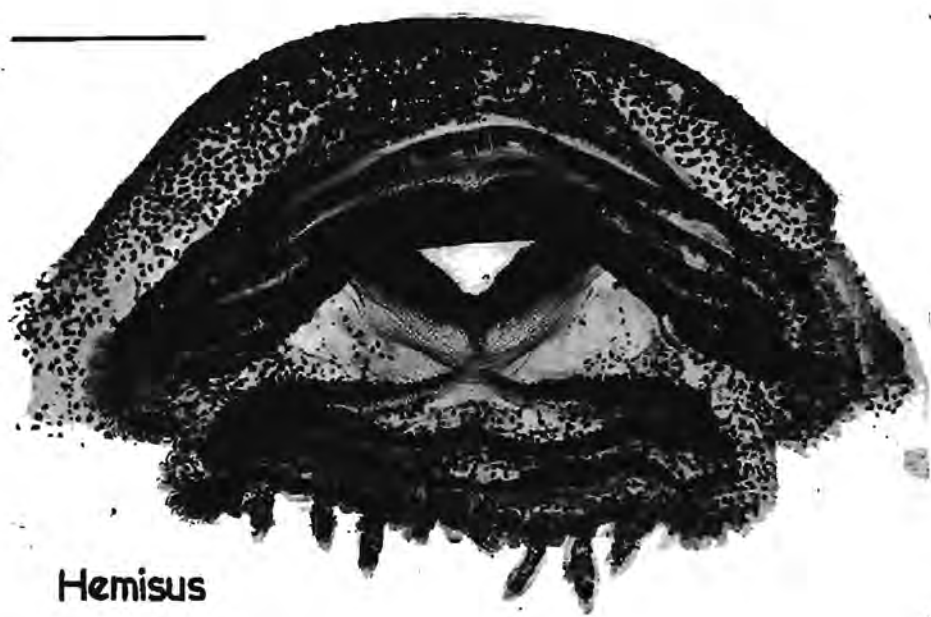
**Cacosternum**



**Phrynobatrachus**



**Natalobatrachus**



**Hemisus**

1. One or more rows of supra-angular keratodonts . . . . . 2  
 — *Supra-angular keratodonts absent*; two sparse rows of simple pointed infra-angular keratodonts . . . . . **Hildebrandtia**
2. Three or more rows of supra-angular keratodonts; three rows of infra-angular keratodonts . . . . . 3  
 — *One row or two rows of supra-angular keratodonts*, a rudimentary third row rarely present. *Two rows of infra-angular keratodonts* . . . . . **Ptychadena**
3. Infrarostrodont pigmented along its edge broadly or narrowly . . . . . 4  
 — *Infrarostrodont deep and pigmented to its base* . . . . . **Strongylopus**
4. Serrations on rostrodonts well-developed. One row of supra-angular keratodonts uninterrupted medially . . . . . 5  
 — *Serrations on rostrodonts very poorly developed. Two rows of supra-angular keratodonts uninterrupted*, keratodonts very well-developed and long. *Tail rounded and about as high as the trunk* . . . . . **Pyxicephalus** (sensu stricto)
5. Suprarostrodont surface and edge strongly curved, the edge with notches on each side of the median lobe. Infrarostrodont surface and edge mainly rounded with a median V, extremities parallel. Serrations of rostrodonts tend to be restricted to the medial regions . . . . . 6  
 — *Suprarostrodont surface slightly curved, the edge with a slight even sigmoid curvature. Infrarostrodont edge widely V-shaped with little curvature except at the extremities. Serrations of rostrodonts extending far laterally and decreasing in size gradually* . . . . . **Hylarana**
6. *Tail not as high as body and not more than 5/3 the length of the head and trunk. Medial wall of spiracular opening closely applied to the body wall. Spiracular tube opens dorso-posteriorly broadly (i.e. with little constriction). Spur develops beside the fifth toe as soon as this is developed* . . . . . **Tomopterna** (*Pyxicephalus*)  
 — *Tail may be as high or higher than body and more than 5/3 the length of the head and trunk. Medial wall of spiracular opening may be raised from the body wall. Opening of spiracular tube typically somewhat constricted. Spur absent from foot* . . . . . **Rana** (sensu stricto)

## Pipidae

## D. Species

### *Xenopus*

1. Region between nostrils unpigmented except for heavy pigmentation at the edges of the nostrils extending into the nostrils. Nostrils distinctly oblique in anterolaterad posteromedial direction, the posterior edge making an angle of approximately 20° or more with a transverse line. Internarial distance tends to be <1.5x nostril width . . . . . **muelleri**  
 — Not as above . . . . . 2
2. Region between the nostrils pigmented, slightly more heavily at the edges of the nostrils than medially. Nostrils almost transverse, the posterior edges making angles



*Hildebrandtia*



*Ptychadena*



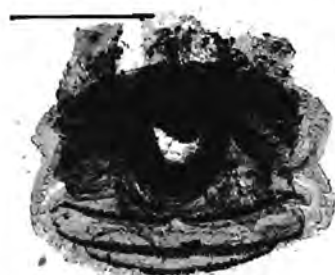
*Rana*



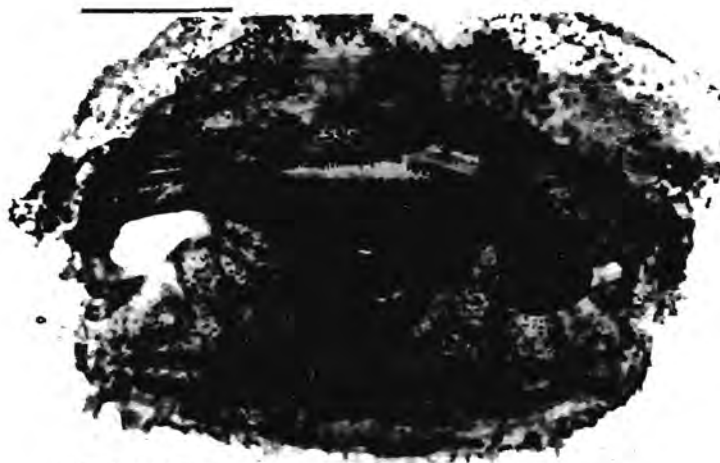
*Strongylopus*



Pyxicephalus



Tomopterna



Hylarana



- of 15° or less in the anterolaterad-posteromedial direction with a transverse line. Internarial distance tends to be  $> 1.5\times$  nostril width. Tentacles at the base approximately 1/20th the width of the mouth . . . . . **laevis**  
 —Not as above . . . . . **gilli**

### *Leptodactylidae*

#### *Heleophryne*

1. Infrarostrodont present . . . . . **natalensis**  
 —Infrarostrodont absent . . . . . 2  
 2. Nostrils directed only slightly more laterally than forward (angle between the axes of two nostrils 80°). Margin of nostrils slightly scalloped . . . . . **purcelli**  
 —Nostrils directed distinctly more laterally than forward and also laterally rather than dorsally. Margin of nostrils smooth, with single medial projection . . . . . **rosei**

### *Microhylidae*

#### *Phrynomerus*

1. Spiracle close to posterior end of trunk; dorsum usually silvery with black vertebras stripe . . . . . **bifasciatus**  
 —Not as above . . . . . 2  
 2. Distance to spiracle forward from posterior end of trunk equal to  $\frac{1}{4}$  total length of head and trunk; dorsum usually mottled silver and black . . . . . **annectens**  
 —Not as above . . . . . **affinis**

### *Bufo* and *Schismaderma*

1. A projection present on the back forming an almost flat surface with a curved, slightly raised edge posteriorly extending to the posterior limit of the eyes. Eyes small . . . . . **S. carens**  
 —Postorbital region dorsally rounded in the transverse direction (*Bufo* s.s.) . . . . . 2  
 2. Tail more than twice ( $\pm 2\frac{1}{2}x$ ) as long as the rest of the body. Egg-strings single and beaded . . . . . **B. rosei**  
 —Tail approximately  $1\frac{1}{2}x$  as long as the rest of the body . . . . . 3  
 3. The following are useful criteria for descriptions and diagnoses of other *Bufo* species: melanophores only present—iridiophores, xanthophores etc. present; ventral fin pigmented—ventral fin unpigmented; nostril rim round—nostril rim with distinct median projection; internarial/nostril width ratios, pigmentation patterns (e.g. crescent in gular region, proximal region of dorsal fin more densely pigmented), disposition of papillae within the oral disc, lengths of rows of keratodonts relative to one and another and to rostrodonts, etc.

*Ranidae**Phrynobatrachinae*

*Microbatrachella* (with characters as for genus) . . . . . **capensis**  
*Cacosternum*

1. Four rows of supra-angular keratodonts, one uninterrupted. Extra-ocular proportion approximately 40-45% . . . . . **namaquense**  
 —Less than four rows of supra-angular keratodonts, or if four rows, extra-ocular proportion negligible . . . . . 2
2. Two (or three?) rows of supra-angular keratodonts, one uninterrupted. Aboral row of infra-angular keratodonts about  $\frac{1}{2}$  as long as row proximal to it. Eyes not lateral . . . . . **capense**  
 —Three, rarely four, rows of supra-angular keratodonts, one uninterrupted. Aboral row of infra-angular keratodonts almost as long as row proximal to it. Extra-ocular proportion negligible (eyes lateral) . . . . . 3
3. Tadpole dark grey. Spiracular opening directed dorsally and somewhat posteriorly . . . . . **nanum**  
 —Tadpole brown, cream or green, rarely grey. Spiracular opening directed posteriorly and slightly dorsally . . . . . **boettgeri**

*Phrynobatrachus*

Differential features unknown: *natalensis*, *ukingensis*, *acridoides*.

*Natalobatrachus* (with characters as for genus) . . . . . **bonebergi**

*Arthroleptella*

Differential features unknown: *lightfooti*, *hewitti*.

*Anhydrophyrne* (with characters as for genus) . . . . . **rattrayi**

*Hemisinae**Hemisus*

1. Anterior half of tail, except edges of dorsal and ventral fins, has a single large pigmented area . . . . . **marmoratus**  
 —Posterior half of tail typically distinctly more pigmented than anterior half, sometimes being quite black, sometimes having only a faint longitudinal stripe . . . **guttatum**

*Rhacophorinae*

*Chiromantis* (with characters as for genus) . . . . . **xerampelina**

*Hyperoliinae**Leptopelis*

1. In addition to marginal oral papillae a row of intra-marginal papillae mentally, extending laterally as far as the middle (of 3) row of infra-angular keratodonts. Serrations of suprarostrodont very poorly developed, scarcely visible except medially. Lengths (chords) of the three rows of infra-angular keratodonts almost exactly equal. Extra-ocular proportion approximately 25%. Fins only deeper than tail muscles in last  $\frac{1}{4}$

- of tail. Proximal  $\frac{1}{3}$  of ventral fin unpigmented. Abdominal region ventrally unpigmented. Ocular elygium present (always?), but not easily detected .. **natalensis**  
 —Not as above .. .. . 2  
 2. Discs on toes not visible in 5-toed stages .. .. **xenodactylus** and (?=) **bocagei**  
 —Discs on toes visible in 5-toed stages .. .. . **concolor**

*Hylambates*

1. *Two rows of infra-angular keratodonts (interrupted)* .. .. . **senegalensis**  
 —Two interrupted rows of infra-angular keratodonts and a very short aboral uninterrupted row .. .. . 2  
 2. *Very distinct light (silvery or golden) stripe along the axis of the tail.* No mental gap in oral papillae .. .. . **wealei**  
 —*Tail without a distinct light stripe.* Mental gap in the oral papillae present .. .. **maculatus**

*Hyperolius*

1. Aboral (mental) row of infra-angular keratodonts more than  $\frac{1}{2}$  as long as row proximal to it .. .. . 2  
 —Mental row of infra-angular keratodonts less than  $\frac{1}{2}$  as long as row proximal to it .. 3  
 2. Posterior region of tail (approximately  $\frac{1}{3}$ ) black or dusky, black pigment present along ventral and dorsal limits of caudal muscles .. .. . **pusillus**  
 —Not as above .. .. . **nasutus?**  
 3. *Posterior region of tail (approximately  $\frac{1}{3}$  to  $\frac{1}{2}$ ) black* .. .. . **marmoratus**  
 —Posterior region of tail not pigmented very much differently to rest .. .. . 4  
 4. Pigment on the tail concentrated into longitudinal stripes, one of which is along the axis .. .. . 5  
 —Mottling of tail fairly uniform, longitudinal stripes absent .. .. . 6  
 5. Margins, and longitudinal axis, of tail speckled densely with black .. .. . **tuberilinguis**  
 —Broad axial stripe and narrow stripes at the dorsal and ventral limits of the caudal muscles .. .. . **horstockii**  
 6. Differential features unknown .. .. . **semidiscus, puncticulatus**

*Afrixalus*

1. *One row of infra-angular keratodonts present.* In addition to the marginal oral papillae, two rows of papillae (intra-marginal) present in the mental region, the distal row typically medially interrupted .. .. . **fornasinii**  
 —Infra-angular keratodonts absent .. .. . 2  
 2. Oral papillae form a single, marginal, row .. .. . **brachynemis knysnae**  
 —In addition to the marginal oral papillae, a row of papillae (intra-marginal) present in the mental region .. .. . **spinifrons**

*Raninae**Ptychadena*

1. One row of supra-angular keratodonts .. .. . 2  
 —Two rows of supra-angular keratodonts (probably rarely a rudimentary third row, perhaps still more rarely a fourth) .. .. . 3

2. *One row of oral papillae mentally.* Eyes nearly lateral. Distal (mental, aboral) row of infra-angular keratodonts shorter than the proximal row . . . . . **subpunctata**  
 — Oral papillae mentally in a multiple row, more than two deep at the ends of distal row of infra-angular keratodonts. Distal (mental, aboral) row of infra-angular keratodonts longer than proximal row or just as long; proximal row typically interrupted medially . . . . . **anchietae**
3. Multiple row of oral papillae mentally. Infrarostrodont with a deep pigmented region, being pigmented nearly to the base. *Proximal (adoral) row of supra-angular keratodonts with only a small interruption medially* . . . . . **mascareniensis**  
 — Single or multiple row of oral papillae mentally. Infrarostrodont with a narrow or deep pigmented region. Proximal row of supra-angular keratodonts divided into two portions by an interruption approximately as big as each portion of the row or larger . . . . . 4
4. Infrarostrodont with a narrow or moderately deep pigmented region. The two portions of the proximal row of supra-angular keratodonts separated by a space approximately as big as each portion. Multiple row of oral papillae mentally . . . . . **oxyrhynchus**  
 — Infrarostrodont with a deep pigmented region. Proximal row of supra-angular keratodonts divided into two portions which are small in comparison with the space between them. Single or multiple row of oral papillae mentally . . . . . 5
5. Multiple or single row of oral papillae mentally. Head anteriorly rounded in dorsal view, nostrils directed anteriorly and laterally rather than dorsally. Eyes, although not lateral (extra-ocular proportion approx. 25%), are directed laterally, the head being nearly vertical in the orbital region. Circumorbital region pigmented . . . . . **vernayi**  
 — Single row of oral papillae mentally. Head anteriorly rather pointed in dorsal view, nostrils dorsolaterally rather than anteriorly. Eyes directed dorsolaterally. Circumorbital region unpigmented . . . . . **taenioscelis**  
*Hildebrandtia* (with characters as for genus) . . . . . **ornata**  
*Hylarana* (with characters as for genus) . . . . . **darlingi**  
*Pyxicephalus* (with characters as for genus) . . . . . **adspersus**  
*Tomopterna*
1. *Three or more interrupted rows of supra-angular keratodonts*, in addition to an uninterrupted row (distally). Distal (aboral, mental) row of infra-angular keratodonts about  $\frac{3}{4}$  as long as row proximal to it or longer. Oral papillae in a single row mentally along about  $\frac{1}{4}$  the breadth of the distal row of infra-angular keratodonts. Ocular elygium present and merging into the pigment between the eyes . . . . . **natalensis**  
 — Not as above . . . . . 2
2. *Two interrupted rows of supra-angular keratodonts*, in addition to an uninterrupted row (distally). Distal (aboral, mental) row of infra-angular keratodonts about half as long as row proximal to it. Oral papillae in a single row mentally along the breadth of the distal row of infra-angular keratodonts approximately. Ocular elygium absent . . . . . **delalandei**  
 — Not as above . . . . . **marmoratus**

*Rana sensu stricto*

1. *Proximal  $\frac{1}{4}$  of ventral fin not very narrow, proximal  $\frac{1}{4}$  of dorsal fin well developed. Tip of tail pointed. Cavity within nostrils slightly or distinctly visible from above* . . . 2
- *Ventral fin very narrow anteriorly, dorsal fin virtually absent on proximal  $\frac{1}{5}$  of tail. Tip of tail rounded rather than pointed. Nostrils open laterally rather than dorsally, nostril rims but not the cavities within visible from above* . . . . . 3
2. *Dorsal fin curved dorsally forwards into the trunk region. Posterior region of tail (approx.  $\frac{1}{5}$ ) typically dark. Spiracular opening somewhat constricted and directed dorsoposteriorly. Medial (dorsal) rim of nostril has a projection with a curvature (convex) about equal to that of the lateral (ventral) rim of the nostril (concave)* . . . . . **fuscigula**
- *Dorsal fin extends in a long curve from the trunk to the tail. Spiracular tube extends posterodorsally, but the markedly constricted opening is directed more posteriorly. Medial (dorsal) rim of nostril has a projection with a curvature greater than that of the lateral (ventral) rim, this projection partially obscuring the view from above into the cavity of the nostril* . . . . . **angolensis**
3. *Six or more rows of supra-angular keratodonts, one of which almost angular in position and separated by a larger gap than between the other rows. Spiracular opening unconstricted and visible laterally. Rostrodonts, particularly the suprarostrodont with very feeble serrations. Neuromast organs (sensory line organs) of head very distinct with dark pigment surrounding the pores* . . . . . **umbraculata?**
- *Five or less rows of supra-angular keratodonts, the adoral row not angular in position nor widely separated from the other rows. Neuromast organs moderately distinct with slight pigmentation of the pores in the head region. Spiracular opening unconstricted but not visible laterally as the lateral wall of the spiracular tube projects beyond the medial wall* . . . . . **vertebralis**

*Strongylopus*

1. *Vertical height of tail greater than height of trunk. Tail mottled. Tip of tail pointed* . . . . . **fasciatus**
- *Vertical height of tail not greater than height of trunk. Tail not mottled. Tip of tail rounded or pointed* . . . . . 2
2. *Eyes without elygium or umbraculum. Tail not distinctly narrower anteriorly than further posteriorly. Pigmentation of tail not markedly greater posteriorly* . . . **grayi**
- *Elygium present. Tail typically distinctly narrower anteriorly than further posteriorly. Posterior region of tail may be dark* . . . . . 3
3. *Posterior region of tail (approx.  $\frac{1}{5}$ ) dark, the rest more or less transparent* . . . **wageri**
- *Pigmentation of tail not markedly greater posteriorly* . . . . . **hymenopus**

## SOME RELEVANT LITERATURE NOT SPECIFICALLY ON SOUTHERN AFRICAN TADPOLES

A full review of literature on general principles of tadpole taxonomy is intended in the future. Brief reference to some indicative works nevertheless seems worth-while.

The rôle of tadpoles in systematic studies, and the classification of tadpoles into

natural groups has been studied or discussed by a number of authors: Lataste (1876, 1878 and 1879), Günther (1882), Cope (1889), Boulenger (1881, 1918a and 1918b), Annandale and Rao (1918), Noble (1925a, 1925b, 1926a, 1927 etc.), Power (1929 and 1930), Orton (1952, 1953, 1955 and 1957) and others. Recently Griffiths (1963) has reviewed the relationship of the study of tadpoles to the phylogeny of the Salientia. Besides these authors Rao (1918) and Parker (1934), among others, have drawn attention to the similarity of tadpoles within a natural group; Boulenger minimizes the significance of tadpoles in taxonomic studies, possibly as a reaction to Günther's remarks in the preface to Boulenger's catalogue (compare Günther 1882 and Boulenger 1918b).

The tadpole mouth-parts, apparently first carefully described by Swammerdam (1737), were described for six European species by van Bambeke in 1863; Hinckley (1881) was apparently the first to use mouth-parts in the description of most of the species of tadpoles of an area (Milton, Mass., U.S.A.), while in 1889 Héron-Royer and van Bambeke used mouth-parts only for a systematic study of the tadpoles of Europe. Lataste (1876, 1878 and 1879) used the spiracle as a classificatory feature for the first time, while Boulenger (1886) and Willey (1893) were apparently the first to recognize the position of the vent as a diagnostic feature. Hinckley (1882) commented on variations in the spiracle, but these do not limit the value of the spiracle as a classificatory and diagnostic feature. The spiracles have been found to indicate groups at subordinal level (Orton, 1953 and 1957), and the vent position has been found to vary approximately at family level; mouth-parts vary at all levels from subordinal to subspecific and local population level.

Diagnostic features of tadpoles (and/or eggs) of Anura have been arranged as keys by Boulenger (1891) and several subsequent authors for Europe, by Wright and Wright for U.S.A. east of the Mississippi (1924, eggs) and for U.S.A. and Canada (1949, 3rd Ed.), by Orton (1952) for U.S.A. and Canada (genera). Other keys are of more limited scope, either dealing with the Anura of a smaller area, e.g. Storer (1925) for California, Wright (1932) for the Okefinokee swamp, U.S.A., Smith (1934) for Kansas, Orton (1939) for New Hampshire, Walker (1946) for Ohio, Chermack (1956) for Alabama, or with a group of the Anura of an area, e.g. Rao (1918) for the Engystomidae of India, Bragg (1944) for the Spadefoot Toads of Oklahoma, Liu (1950) for the *Bufo*s of West China. Some descriptions of tadpoles cover the majority of species of an area without keys having been constructed, or with keys to some groups only, e.g. Liu (1950) for West China, Kirtisinghe (1958) for Ceylon and Starrett (1960) for Middle America. Other descriptive studies dealing with a number of species include Wright (1929), Duellman (1963) and Eibl-Eibesfeldt (1953), the last of these works dealing with the identification of tadpoles (of Europe) by their behaviour.

There have been a number of studies of tadpole polymorphism, variability of diagnostic characters and the validity of classificatory features of tadpoles. Thus Scott-Birabén and Fernández-Marcinowski (1921) and Nichols (1937) discussed variation in tadpoles, particularly the keratodonts (horny teeth), and the latter author has a useful bibliography; more recently there have been the works of Turner (1952), Bresler (1954), Bresler and Bragg (1954), Orton (1954), Bragg (1957a and 1957b), Pisanó (1958), Berger (1959) on difficulties in identifying tadpoles, Gosner (1959) who deals with the value of the form of the keratodonts in diagnosis and classification, Bragg and Bragg (1959), Hampton and Volpe (1963) and Bragg, Matthews and Kinsinger (1964).

Useful information or techniques for identifying tadpoles are contained in a number of recent articles, such as those of Gosner and Black (1958) and Gosner (1960) while incidental comments bearing on the significance of tadpoles in classification are to be found in discussions of tadpole adaptations, e.g. Lutz (1948) and Lutz (1949).

#### FIELD KEYS

The features common to all the species of each genus of Southern African tadpoles studied, in other words the generic characters, are so striking and constant that there is no advantage to be gained by constructing a field key which leads directly to species. A key which leads directly to the genera, instead of via the families and sub-families, is the only additional key required for field use, since the keys to the species of each genus are suitable for use in the field.

Such a field key to the genera is represented in fig. 4. The key is essentially dichotomous and is designed so that only a few simple features need be observed in order that a specimen may be placed in the correct genus. Criteria used more than once have been arranged, as far as possible, at the same horizontal level in all the different pathways in the key. The dotted reticulations represent means of returning to the correct path after a difficult choice or a mistake. Thus if the oral disc is overlooked (or absent because the specimen is too far advanced in metamorphosis—in which case adult features should be used for identification), the finding of a single sinistral spiracle will lead back to the correct path. If the ratio of the internarial distance to the nostril width is between 6x and 10x a choice in either direction should lead to the correct genus without any trouble, since this situation should arise when the correct genus is to be reached via the choice 6x, and this direction is also reached via 10x and the reticulation. It is thus obvious that, when in doubt whether the choice should be for 10x or 6x, 10x should be chosen as this permits a return to internarial distance 6x the nostril width or less. Some *Ptychadena* species may be expected to present a difficult choice in this character.

#### NOTES AND DISCUSSION

##### Species not included in the keys

The non-aquatic tadpoles of *Breviceps* are all likely to prove to be very similar and a comparative study is much less important than a thorough study of the development of any species based on serial sections and reconstructions, and experimental embryological studies of the early stages. The tadpoles of the various species of *Bufo* may be expected to show differential features, such as the presence of iridiophores as well as melanophores, presence of unpigmented or especially heavily pigmented areas around the nostrils, relative size and position of the nostrils, as well as their shape, number and position of intramarginal papillae, etc. The difficulty experienced in identifying juveniles is the major obstacle to using tadpoles caught in the field for description of the tadpoles of the various species of *Bufo*. A comparative biometric study of tadpoles of known parentage is called for.

Apart from these genera there are only about 6 species of Anura occurring well within the Southern African region the tadpoles of which are still scarcely or quite unknown, at least as far as described diagnostic features are concerned. Such species are *Xenopus gilli*,

*Phrynobatrachus ukingensis* (*mababiensis* subsp.), *Arthroleptella hewitti*, *Leptopelis concolor* and *Hyperolius nasutus* and *H. puncticulatus*. To these *Leptopelis xenodactylus* must be added if it is not a subspecies of *L. bocagei*, as well as *Tomopterna* (*Pyxicephalus*) *marmoratus* if it is not a synonym or subspecies of *Tomopterna delalandei*. Of the species mentioned the tadpoles of *Phrynobatrachus ukingensis* have been reared by Wager (see Wager, 1962), and the young stages, which are very similar to those of *P. natalensis*, were also collected during the present study from Inhaca. Recently Wager has reared *Hyperolius nasutus* tadpoles (personal communication). Tadpoles collected at Empangeni are thought to be *Hyperolius puncticulatus*, but they are so like those of *H. semidiscus*, as are the juveniles, that a careful study of the two species will have to be made. *Xenopus gilli*, *Leptopelis concolor* and *Arthroleptella hewitti* remain to be studied, as well as the doubtful species *Leptopelis xenodactylus* and *Tomopterna marmoratus*. A comparison of the tadpoles of the former with those of *Leptopelis bocagei* is particularly needed.

Besides the species occurring well within the South African region which require particular study, there are a number of species occurring in Southern Rhodesia, South West Africa and Mozambique which should be studied in case their distribution is more extensive than at present thought, if the immediate purpose, to produce keys to all anuran species occurring in the areas commonly studied by investigators in South Africa, is to be achieved. These species are *Arthroleptis stenodactylus* (known in Northern Natal) and *A. xenodactylodes*, *Phrynobatrachus acridoides*, *Ptychadena uzungwensis*, *Phrynomerus affinis* (if this a distinct species), and *Tomopterna* (*Pyxicephalus*) *tuberculosus*.

#### Notes on the Keys

Constructing a key when it is known that some species are undescribed, or very inadequately described (i.e. in the tadpole stage) presents some particular difficulties, principal among which is naturally that generic characters chosen may not apply to the undescribed species, and that an undescribed species may have characters intermediate between the alternatives in a step in the key and overlapping both.

It is improbable that, using the generic characters chosen, an undescribed species will not be assigned to the correct genus. The second difficulty, that a newly described species is found to have characters which overlap the alternatives in a step in a key, must be dealt with when tadpoles of all the species have been identified and described. It does, however, mean that priority must be given to identification of tadpoles of as many as possible of the species, and detailed studies of the validity of criteria for large samples must be relegated to a secondary place in priority—the overlap of known criteria will at most be infrequent and relatively slight, leaving the keys valid for most of a sample, while the overlap of the unknown with the known may be overwhelming. It is recognized that, in many cases, insufficient material from too few localities has been examined; but the keys will have to be revised to include the remaining species, and any corrections based on more material can be made at this time.

#### Notes on the genera and species included in the keys

*Xenopus*. The criteria used for distinguishing *X. laevis* and *X. muelleri* are valid for the former species from various localities and for *X. muelleri* from Kosi Bay. In muddy water



*X. laevis* may be less pigmented than usual and this then makes the pigmentation criterion difficult to use. Considerable changes in the form, position and size of the nostrils take place late in metamorphosis and should be looked for.

*Brief Provisional Diagnosis of Undescribed Species.* *X. muelleri*: as for *X. laevis*, but with region between the nostrils unpigmented medially, densely pigmented adjacent to the nostrils, the pigmentation extending into the nostrils; nostrils oblique (about 20°) in the anterolaterad-posteromedial direction (Kosi Bay). *X. gilli* has not yet been described.

*Heleophryne.* The criteria used are valid for various *H. purcelli*, including the *H. regis* of the Transvaal Museum which is somewhat different from the other samples in other respects and warrants re-examination of assignment of *H. regis* as a subspecies of *H. purcelli*. The criteria are valid for *H. rosei* from Skeleton Gorge. The *H. purcelli*—*H. rosei* complex appears to be relatively homogeneous and relatively widely separated from *H. natalensis*.

*Bufo.* The tadpoles of *Bufo* are rather similar and a comprehensive biometric study of the various species is required. The data for *B. rosei* are based on Power and Rose, 1929.

*Breviceps.* As mentioned above the interest in *Breviceps* lies at the generic level. The mental protuberance mentioned by de Villiers and used as a diagnostic feature is not easily seen and must be replaced when better ones can be found by comparative study.

*Phrynomerus.* The data for *P. annectens* are based on Inger, 1959.

*Microbatrachella.* The data for *Microbatrachella* are from Hewitt, 1925.

*Cacosternum.* *C. boettgeri* and *C. nanum* are rather similar. Insufficient material of *C. nanum* is available for detailed study of the differential characters; the colouration of the species in Pietermaritzburg is quite distinct, but Power (1927b) refers to gray colouration in *C. boettgeri* from Griqualand West. Power (op. cit., p. 250) has a comment which may be interpreted to mean that a mental gap is occasionally present in the oral papillae: "The row of horny teeth show a considerable amount of variation, there being occasionally a short row bordering the lower lip as in the case of the genus *Bufo*." A mental gap has not been observed in any specimen of *C. boettgeri* from Pietermaritzburg.

*Brief Provisional Diagnosis of Undescribed Species.* *C. namaquense*: as for *C. boettgeri* in most respects, but eyes not lateral, —extra-ocular proportion  $\pm 40\text{--}45\%$ —, four rows of supra-angular keratodonts, one uninterrupted, rostrodonts well-developed (Koeberg).

*C. nanum*: as for *C. boettgeri* which it very closely resembles, but dark grey; another differential character, which may not, however, be reliable, is that the tail is relatively not as high as that of *C. boettgeri* being scarcely as high at its maximum as the trunk (Pietermaritzburg, low-lying and high areas). Amplexus between *C. nanum* and *C. boettgeri* occurs readily in the laboratory and the development of the hybrids is normal at least to the free-swimming larval stage. There is thus no ethological barrier preventing amplexus altogether, nor complete inviability of hybrids between these two species.

*C. boettgeri* and *C. nanum* may be considered as forming one sub-group and *C. namaquense* and *C. capense* another on the basis of the lateral position of the eyes in the former two species (extra-ocular proportion negligible) while the extra-ocular proportion in *C. namaquense* is  $\pm 40\text{--}45\%$  and in *C. capense* is  $\pm 35\text{--}40\%$ .

*Phrynobatrachus.* The generic characters chosen apply also to *P. francisci*. The great change in the mental oral papillae from the very long papillae (relative to the size of the oral disc)

in the young stages to short in the metamorphosing stages is note-worthy (see Power, 1927a, and Lamotte and Dzieduszycka, 1958).

*Natalobatrachus*. The illustration of the mouth-parts in Wager (1931) does not show two features observed in the specimens of *Natalobatrachus* tadpoles examined. In the first place there is a very deep angular cleft and in the second place the mental row of oral papillae is double, not single as illustrated by Wager (N.B. By a double row is meant that the bases of the papillae are crowded so that the papillae project at two different angles. This is not the same as two rows).

*Anhydrophyrne*. The data for *Anhydrophyrne* are from Hewitt, 1919.

*Arthroleptella*. The presence of rostral cartilages—suprarostalia and infrarostalia—and the vestiges of a lateral line system, reported by de Villiers (1929c, pp. 493 and 488) is note-worthy, as it indicates, as de Villiers remarked (p. 493), that *Arthroleptella* has only recently adopted the habit of laying eggs out of water.

De Villiers (*op. cit.*, pp. 486-487) could not find a spiracular opening as reported by Power and Rose (1929, p. 114) in older tadpoles. There is, in fact, no spiracle.

*Chiromantis*. Wager (1926) represented the oral papillae of *Chiromantis xerampelina* as forming a continuous row across the mentum. A mental gap was found in the specimens examined (from St. Lucia) and this agrees with the diagram of *C. rufescens* in Guibé and Lamotte (1959a) (as *Hylambates leonardi*), Lamotte and Perret (1961b) and Schiøtz (1963). The extra-ocular proportion is not shown in Wager's diagrams or ascertainable from his description. Unlike *Hyperolius*, *Afrixalus* and *Hylambatus* the eyes are not lateral, the extra-ocular proportion being  $\pm 30\%$ . The vent, the position of which is not mentioned by Wager, is, like that of *Hyperolius*, *Afrixalus* and *Hylambates* dextral and not marginal, but unlike the genera mentioned the vent is not basicaudal but nevertheless only a short distance along the fin.

*Leptopelis*. The general form of described tadpoles of *Leptopelis*, including the long, pointed, rather shallow tail, does not vary very much from one species to another. The continuity of the supra-angular and infra-angular oral papillae without an angular notch intervening is characteristic as is the presence of two rows of oral papillae across the mentum. The beautiful drawings of Schiøtz represent the facies very well, both as regards the whole animal and the mouth-parts. The continuity of supra-angular and infra-angular oral papillae is characteristic of the *Hyperoliinae* (*Leptopelis*, *Hyperolius*, *Afrixalus* and *Hylambates*).

It is quite probable that *L. xenodactylus* Poynton will be found to be a synonym of *L. bocagei* or a subspecies of this species; *Leptopelis bocagei haasi* Mertens shows variation from the typical form of about the same order as *L. xenodactylus*.

*Hyperolius*. The tadpoles of *Hyperolius* species are all similar and clearly form a natural group. Power and Rose (1929) state of *Hyperolius horstockii*: "Anal opening median, on the lower edge of the subcaudal fin". Inger (1959) comments: "Power and Rose (1929) describe younger larvae attributed to *horstockii* as having the anus in a median position, which is very unusual for ranid or rhacophorid tadpoles". The tadpoles examined by Inger and those examined in the present study have a dextral vent.

The mouth-parts of the known *Hyperolius* tadpoles are very similar; *H. pusillus*, however, differs from all the rest in having the aboral (mental) row of infra-angular kera-

todonts nearly as long as the row proximal to it instead of less than  $\frac{1}{2}$  as long. Owing to the similarity of *H. nasutus* adults to *H. pusillus* this character is used provisionally to separate off the unknown tadpole of *H. nasutus* as well as *H. pusillus*. *H. pusillus* and *H. nasutus* may prove to represent a sub-group of *Hyperolius* in Southern Africa.

*Afrixalus*. The tadpoles of *Afrixalus* spp. are very similar and characteristic and clearly form a natural group. The data for *Afrixalus spinifrons* are taken from Wager (1960a), who unfortunately does not state the locality of his material or the basis of separating *A. spinifrons* from *A. brachycnemis*. The tadpoles described as *A. spinifrons* by Power (1933) and Inger (1959) are probably *A. brachycnemis knysnae*. Their descriptions agree with material from Pietermaritzburg which is apparently *A. brachycnemis knysnae* as judged from the juvenile. *A. brachycnemis brachycnemis* tadpoles remain to be identified.

*Hylambates* (including *Kassina*). The tadpoles of *Hylambates maculatus* and *Kassina senegalensis* and *Kassina wealei* have the same highly characteristic facies. There can be no justification for separating these species into two genera, and *Hylambates* being the older genus, this name is adopted as the generic name for *Anura* with tadpoles of the *Hylambates maculatus* type. Highly characteristic is a pair of keratinizations between the adoral infra-angular keratodonts and the infrarostrodont. These have been figured in several diagrams, but omitted in Wager (1960a).

*Pyxicephalus* and *Tomopterna*. The tadpoles of *Pyxicephalus adspersus* are very different from those of *Tomopterna* (*Pyxicephalus*) *delalandei* and *T. (P.) natalensis*. Since the tadpoles of the latter two species have a number of features in common and have been placed in a different genus on adult characters by some authors, they are best transferred to the genus *Tomopterna*, the genus in question. It should be noted that *Pyxicephalus cimmuratai* from Somaliland has similar tadpoles to those of *Pyxicephalus adspersus*. The very much smaller tadpoles of the form referred to variously as *Pyxicephalus edulis* and *Pyxicephalus adspersus edulis* in East Africa are undescribed except for their size (10 mm. according to Loveridge, i.e.  $\frac{2}{3}$  the size of the tadpoles of *Pyxicephalus adspersus*, at metamorphosis).

Power (1927c, p. 413) reported of *T. delalandei* tadpoles that "some taken on the sea-shore at Fish Hoek, C.P. showed not a vestige of horny teeth; the beak was well developed". No *T. delalandei* adults have been placed on record as having been collected on the Cape Peninsula as far as could be ascertained. If the tadpoles collected by Power were not merely at the stage when the keratodonts are being lost, or have not yet developed although the rostrodonts have, neither of which stages are very long and therefore likely to be encountered in a sample, the tadpoles, if they were *Tomopterna* tadpoles, are likely to represent at least a different sub-species of *T. delalandei*.

*Rana sensu stricto*. The tadpoles of the typical members of this group, *R. fuscigula* and *R. angolensis*, show few specializations and seem to have departed least from the form of the tadpole of the *Rana stock*. The tadpoles of *R. vertebralis* and *R. umbraculata* (?), are, like the post-metamorphic animals, adapted to a swift stream, clear water, habitat. Metamorphosing tadpoles obtained from Organ-Pipe Pass in the Drakensberg (near Cathedral Peak) could be identified as *R. vertebralis*. Only two still had the tadpole mouth-parts and they differed from the description of *R. vertebralis* tadpoles given by Hewitt (1927) in several respects. That Hewitt's description is accurate may be judged by examination of the material preserved in the Transvaal Museum. *R. vertebralis* was described from an

immature specimen and the subsequently described and similar *R. umbraculata* was assigned to *R. vertebralis* as being the adult form (Poynton, 1964, pp. 109-111). It seems most likely that the tadpoles identified by Hewitt (1927) and Fitzsimons (1948) as *R. vertebralis* were in fact *R. umbraculata* tadpoles. Inger (1959) obtained material which was similar to that described as *R. vertebralis*, but had 6 rows of supra-angular keratodonts instead of 8. Hewitt's and Fitzsimons' tadpoles are provisionally assigned to *R. umbraculata* and the following description is given of *R. vertebralis* tadpoles:—

*Brief Provisional Diagnosis of Undescribed Species.*

*R. vertebralis*: as for *R. vertebralis* of Hewitt, 1927 and Fitzsimons, 1948 (= *R. umbraculata*?); but with five rows of supra-angular keratodonts, the adoral row not being situated in the oral angle markedly further from the next row than the spaces between the other rows, lateral line organs surrounded by black pigment discrete from the background pigmentation but not very distinct. Spiracular tube opens broadly, the opening not visible laterally as the distal wall of the spiracular tube is longer than the proximal wall (Organ-Pipe Pass, Cathedral Peak, Drakensberg).

The tadpoles of *R. angolensis* and *R. fuscigula* are rather similar and it is not impossible that the adults are phenotypic variations produced by their being derived from younger and older tadpoles respectively, the tadpoles of *R. fuscigula* tending to delay metamorphosis for a season. An essential step in any study of the relation between *R. angolensis* and *R. fuscigula* is a thorough study of their tadpoles.

*Hylarana*. Limited and rather shrunken material of *H. darlingi* shows similarity to the description of *H. albolabris* tadpoles by Lamotte, Lauwarier and Perret (1957) and Guibé and Lamotte (1958a). It is not possible to say from the descriptions, however, whether the characters chosen to separate *Hylarana* and *Rana* in Southern Africa are applicable to *H. albolabris* and other *Hylarana* species.

*Strongylopus (Rana)*. *Strongylopus* Tschudi was applied by Tschudi to *Strongylopus fasciatus* and by Steindachner to *Strongylopus grayi*. The tadpoles of these species were known to have in common very well-developed and deeply pigmented rostradonts (Hewitt, 1937, p. 99, and without reference to the former, Inger, 1959, p. 519), particularly infra-rostradonts. Similar tadpoles with black-tipped tails, from Cathedral Peak area, could be referred to *S. wageri* (*Rana wageri*). Similar tadpoles to those of *S. wageri*, but without the black pigmentation on the posterior part of the tail were obtained from Giant's Castle. These were assigned to the only remaining ranid of the Drakensberg area not accounted for, namely *S. hymenopus*. Tadpoles from Dooley Hill, Mt. Aux Sources, in the Zoology Department, University of Natal, appear to be similar to the younger *S. hymenopus* tadpoles from Giant's Castle in lacking denser pigmentation posteriorly on the tail, but they were collected at the same time as an adult which may be *S. wageri* (the adult is rather faded). As the *S. wageri* material examined was rather young detailed comparisons of the mouth-parts, etc. of the tadpoles from Dooley Hill could not be made. The following description is tentative.

*Brief Provisional Diagnosis of Undescribed Species*

*S. hymenopus*: as for *S. wageri* but without the posterior region of the tail markedly pigmented (black). As in *S. wageri* there is an elygium present (shade over the eye formed of pigmented epidermis). Oral papillae mentally in a multiple row.

*Ptychadena*. *Ptychadena* tadpoles with three rows of supra-angular keratodonts have not been observed in Southern African material, but are known as an uncommon variant in *P. oxyrhynchus* from West Africa (Guibé and Lamotte, 1958a). Provisionally, therefore, two rows or one row of supra-angular keratodonts is regarded as characteristic of *Ptychadena*. Two infra-angular rows of keratodonts are found in all the described species of *Ptychadena*, which distinguishes it from most of the *Rana*-complex, which, except *Hildebrandtia* which also has two rows, usually, perhaps invariably, have three or more infra-angular rows. (See, however, under *Tomopterna*, the note on *T. delalandei*). A short ridge distal to the aboral (distal) row of infra-angular keratodonts in a specimen of *P. subpunctata* suggests that a very small mental row of keratodonts may occur in addition to the usual two rows of infra-angular keratodonts.

*P. oxyrhynchus* of Power (1927c) from Lobatsi must be referred to *P. anchietae* on the basis of the known distribution and because Power (1935) found *P. oxyrhynchus* tadpoles from Pondoland to differ from his original description and his description of the Pondoland material agrees with the description of *P. oxyrhynchus* tadpoles given by Guibé and Lamotte (1958a) from West African material.

The data for *P. mascareniensis* are from Guibé and Lamotte, 1958a, and Lamotte and Perret, 1961a, and those of mature *P. taenioscelis* tadpoles from Lamotte, Perret and Dzieduszycka, 1959.

The only *Ptychadena* species occurring well within the Southern African region, the tadpoles of which have never been described are *P. vernayi* and *P. porosissima*. A group of tadpoles from the Umfolosi flood-plains are unlike any described tadpoles and clearly *Ptychadena* species. They are therefore either *P. vernayi* or *P. porosissima* (if they belong to a species known to occur in Southern Africa). Material of *P. subpunctata* is available as *P. chobiensis* which is regarded as a synonym. If therefore Loveridge is correct in regarding *P. porosissima* as a synonym of *P. subpunctata* (a possibility not discussed by Poynton), and the known distribution of the forms recognized in Southern Africa is exactly complementary and hence suggestive of subspecies or a cline in a species, then all *Ptychadena* species occurring well within the Southern African area are accounted for. If Loveridge is wrong in synonymizing *P. porosissima* and *P. subpunctata* then one species of *Ptychadena* in Southern Africa remains to be described, viz. either *P. porosissima* or *P. vernayi*, and the species here provisionally described as *P. vernayi* is the other (i.e. it may in fact be *P. porosissima*).

#### *Brief Provisional Diagnoses of Undescribed Species*

*P. subpunctata*: One row of supra-angular keratodonts, this uninterrupted; two rows of infra-angular keratodonts, both of which narrowly interrupted medially (always?), the distal (aboral) row about  $\frac{2}{3}$  as long as the proximal (adoral) row; a very short ridge distal to the infra-angular keratodonts may indicate that a very short third row of keratodonts occurs occasionally mentally; oral papillae in a single row with about 7 intramarginal papillae on each side, 1 at the limit of the distal infra-angular row of keratodonts, 2 at the limit of the proximal row, 1 just below the oral angle and 2 just above (these numbers, of course, subject to variation); pigmented edge of rostrodonts about 1/10 as wide as the length of the rostrodonts, serrations extending laterally almost to the limits, suprarostrodont with a slight even curvature without inflexions and the infrarostrodont obtusely curved medially;

eyes directed laterally and almost lateral in position (extra-ocular proportion about 20%); anterior limit of head very bluntly rounded; spiracular opening unconstricted; tail pointed (Chobi River).

*P. vernayi*?: Similar to *P. taenioscelis*, with oral papillae mentally in a multiple or single row; two rows of supra-angular keratodonts, the proximal row consisting of two short strips separated by a very wide gap; infra-angular keratodonts in two uninterrupted rows the distal of which somewhat shorter to equal in length to the proximal row; rostrodonts moderately broadly pigmented, the width of the pigmented edge of the suprarostrodont about  $\frac{1}{6}$  the length, of the infrarostrodont about  $\frac{1}{4}$  (medially) to  $\frac{1}{3}$ , suprarostrodont with a median lobe twice as broad as the lateral lobes; extra-ocular proportion about 25%, but the eyes are directed laterally as the head is nearly vertical in the orbital region; nostrils small ( $\frac{1}{7}$  or  $\frac{1}{8}$  the size of the internarial distance), with distinct rims, far forward; sensory line organs visible as unpigmented elongated areas mostly arranged transversely; spiracular tube slightly constricted (Umfolosi flood-plain).

*Hildebrantia*. The description of *Hildebrantia ornata moeruensis* tadpoles by Schmidt and Inger (1959) applies to Southern African material of *Hildebrantia ornata ornata*.

*Arthroleptis*. There has never been anything more than superficial descriptions of *Arthroleptis* tadpoles, not even the details of the nostrils, eyes, vent, etc., having been described. The interest lies mainly at the generic level and a thorough description based on serial sections is badly needed. As material was not available the keys have been so arranged as to leave *Arthroleptis* when the other genera have been accounted for. The absence of spiracles is assumed.

*Hemius*. The tadpoles have a number of features unique in Southern African tadpoles.

#### SYSTEMATIC LIST OF REFERENCES

The following list of references is arranged chronologically under each group. Under each genus, besides references to the genus in general, references to tadpoles and breeding data of species which do not occur in Southern Africa are listed, in the case of *Rana* (sensu stricto) and *Bufo* African species only.

\* indicates the best or earliest good description, where such description is at least more or less diagnostic of the species, or differentially diagnostic i.e. makes possible separation from other species of the genus.

† indicates comment of interest, usually the most complete available description, but not including a description diagnostic of the species.

†\* indicates a fairly complete description with some deficiency, either a lack of some important details, or the presence of an important error.

#### *Pipidae*

##### *Xenopus*

- |                             |                                   |
|-----------------------------|-----------------------------------|
| 1862, Wyman, p. 155;        | 1927, de Witte, pp. 60-61;        |
| 1864a, Gray, pp. 315-316;   | 1929, Power, p. 476;              |
| 1864b, Gray, pp. 458-464;   | 1930, de Villiers, p. 485;        |
| 1877, Parker, pp. 625-648;  | 1930, Parker, p. 6;               |
| 1878, Lataste, p. 488;      | 1947, Fitzsimons, p. 17;          |
| 1881, Boulenger, pp. 27-29; | 1957, Orton, pp. 82-83;           |
| 1893, Willey, p. 245;       | 1958a, Guibé and Lamotte, p. 243. |
| 1900, Sampson, pp. 707-708; |                                   |

*Xenopus laevis*

- †1877, Parker, pp. 625-648 as *Dactylethra capensis* is not *X. laevis*, but *X. tropicalis*;  
 \*1890, Leslie, pp. 69-71;  
 1894, Beddard, pp. 101-107;  
 1901, Bles, pp. 220-222;  
 1902, Bles, p. 79;  
 \*1905, Bles, pp. 789-821;  
 1910, Werner, p. 291;  
 1913, Hewitt and Power, p. 175;  
 1913, Dreyer, pp. 341, 352-355;  
 1914, Dreyer, pp. 515-523;  
 1925, Rose, pp. 443-445;  
 1929a, de Villiers, pp. 125-126;  
 1929, Rose, p. 10;  
 1930, Parker, p. 6;  
 1931, Peter, pp. 515-523;  
 1933, Kotthaus, pp. 510-572;  
 1935, Fitzsimons, p. 379;  
 1937, Hewitt, pp. 83 and 114;  
 1945a, Weisz, pp. 163-193;  
 1945b, Weisz, pp. 193-217;  
 1945c, Weisz, pp. 161-169;  
 1953, Loveridge, p. 334;  
 1955a, Wager, pp. 49-53;  
 1956, Nieuwkoop and Faber, pp. 1-243;  
 1957, Balinsky, p. 386;  
 1959, Inger, pp. 510-511;  
 1960, Kalk, pp. 271-276;  
 1961, Cochran, p. 53;  
 1961, van Dijk, pp. 44-45;  
 1962, Rose, pp. 30-31.

*Xenopus muelleri*

- †1882, Peters, p. 181;  
 †1924, Noble, p. 159;  
 1930, Parker, p. 6.

*Xenopus gilli*

Undescribed.

*Leptodactylidae**Heleophryne*

- 1917, Annandale and Rao, p. clxxxvi (as *Helophryne*);  
 1922, Annandale and Hora,  
 1926, Noble, p. 1;  
 1929, Rose, p. 215;  
 1929, Power, pp. 476-477;  
 1934, du Toit, pp. 17 and 20;  
 1953, Orton, p. 71;  
 1960a, Mertens, p. 347;  
 1961, Cochran, pp. 143-144;  
 1963, Griffiths, pp. 253-255;

*Heleophryne natalensis*

- 1913, Hewitt, pp. 475-479, 484;  
 \*1922, Hewitt, pp. 62, 64-65;  
 1925, Hewitt, pp. 365-367;  
 1926b, Hewitt, p. 441;  
 1934, du Toit, pp. 15-16;  
 1937, Hewitt, pp. 118 and 114;  
 1947, Fitzsimons, pp. 58-59;  
 1959, Inger, p. 514;  
 1961, van Dijk, p. 45.

*Heleophryne purcelli regis*

- \*1934, du Toit, p. 13;  
 1946, Fitzsimons, p. 372.

*H. purcelli depressa*

1946, Fitzsimons, Plate XIV fig. 5.

*H. purcelli purcelli* and *H. purcelli* subspecies not specified

- 1934, du Toit, p. 8;  
 1926, Rose, p. 443;  
 1929, Rose, p. 58;  
 1959, Inger, p. 515;  
 1962, Rose, p. 85.

*Heleophryne rosei*

- 1922, Hewitt, p. 64 (quoting personal communications of K. H. Barnard and J. H. Power);  
 \*1925, Hewitt, pp. 365-367;  
 1926, Rose, pp. 441-442;  
 1929, Rose, pp. 52-53 and 215;  
 1934, du Toit, p. 11;  
 1959, Inger, p. 515;  
 1961, Cochran, p. 144;  
 1962, Rose, pp. 80-84;  
 1963, Gow, p. 113.

*Buфонidae**Bufo*

- 1910, Nieden, p. 452 (*B. brauni*); 1940, Mertens, p. 112 (*B. preussi*);  
 1927b, Power, p. 250; 1947, Fitzsimons, p. 21;  
 1933, Scortecci, pp. 24, 28-30, 70 (*B. dodsoni*); 1963, Schiøtz, p. 21 (*B. perreti*).  
 1938, Mertens, pp. 11-12 (*B. preussi*);

*Bufo rosei*

- \*1929, Power, pp. 475 and 476; 1947, Fitzsimons, p. 25;  
 1929, Power and Pose, pp. 109-112; 1962, Rose, pp. 100-101.  
 1929, Rose, pp. 69-71;

*Bufo angusticeps*

- 1926, Rose, pp. 439-440; 1947, Fitzsimons, pp. 22-23;  
 1929, Rose, p. 61; 1962, Rose, pp. 94 and 95.  
 †1929a, de Villiers, pp. 129-134;

*Bufo gariensis*

- 1937, Hewitt, p. 86 (breeding-site only). Tadpole undescribed.

*Bufo amatolica*

Undescribed.

*Bufo vertebralis*

- 1913, Hewitt and Power, pp. 173-174; 1929, Power, pp. 474-475;  
 †1927b, Power, p. 253; 1934, Power, p. 220;  
 1927c, Power, pp. 420-422  
 (*B. vertebralis albiventris*);

*Bufo regularis* (perhaps not all correctly identified as *B. regularis*)

- †1889, Héron-Royer and van Bambeke, 1953, Loveridge, p. 339;  
 pp. 187 and 297-298; 1954a, Lamotte and Zuber-Vogeli, pp. 940-943;  
 1913, Hewitt and Power, p. 173; 1955, Winston, pp. 297-298;  
 1936, Scortecci, pp. 149-152; 1958, Chapman and Chapman, pp. 273-275;  
 1937, Hewitt, p. 84; 1958a, Guibé and Lamotte, p. 244;  
 1938, Mertens, pp. 9-10 (*B. regularis maculatus*); 1960b, Hoesch, p. 264.  
 1947, Fitzsimons, p. 12;

*Bufo gutturalis*

- 1927c, Power, pp. 416-418.

*Bufo rangeri*

- 1937, Hewitt, pp. 86-88.

*Bufo pardalis*

- 1910, Werner, p. 292; 1929, Rose, pp. 62-63 (as *B. regularis*);  
 1926, Rose, pp. 440-441 (as *B. regularis*); 1937, Hewitt, pp. 86-88;  
 1929a, de Villiers, p. 134 (as *B. regularis*, ? *B. pardalis*); 1962, Rose, pp. 94-95.

*Bufo garmani*

- †1927a, Power, pp. 245-247 (as *B. regularis*, ? *B. garmani*);  
 1927c, Power, p. 416 (as *B. regularis*, ? *B. garmani*);  
 1929, Power, p. 476 (as *B. regularis*, ? *B. garmani*);  
 1937, Power, pp. 127-128 (as *B. regularis*, ? *B. garmani*).

*Bufo taitanus*

- 1953, Loveridge, p. 340 (breeding-site and date only).  
 Tadpole undescribed.



*Bufo anotis*

Undescribed.

*Schismaderma (Bufo) carens*

- \*1926a, Power, pp. 115-117; 1947, Fitzsimons, p. 24;
- 1927a, Power, pp. 245 and 247; 1953, Loveridge, p. 338;
- 1929, Power, p. 476; 1957, Balinsky, p. 383.
- 1939, Charter and MacMurray, 386-389;

*Microhylidae**Breviceps*

- 1919, Hewitt, p. 182; 1947, Fitzsimons, pp. 11-12 and 86-88;
- 1922, Hewitt, p. 60; 1950, Miller, p. 105;
- 1937, Hewitt, p. 115; 1960a, Hoesch, p. 11.

*Breviceps adspersus*

- 1926, Rose, p. 439 (quoting personal communication of G. van Dam, as *B. mossambicus*);
- 1929, Power, p. 475 (as *B. parvus*);
- \*1929b, de Villiers, pp. 142-151 (as *B. parvus*);
- 1929, Fitzsimons and van Dam, pp. 152-153 (as *B. parvus*);
- 1929, Rose, p. 49 (as *B. parvus*); 1961, Cochran, p. 175 (as *B. parvus*);
- 1937, Hewitt, p. 116 (as *B. parvus*); 1962, Rose, pp. 87-88 (as *B. parvus*).
- 1960b, Wager, pp. 236-240;

*Breviceps gibbosus*

- 1962, Rose, pp. 88-89; 1962b, Visser, p. 168.

*Breviceps sylvestris*

- 1930, Fitzsimons, pp. 46-47.

*B. mossambicus*, *B. verrucosus*, *B. maculatus*, *B. acutirostris*, *B. fuscus*, *B. montanus*, *B. rosei*, *B. namaquensis*, *B. macrops*, *B. poweri*.  
Development unknown.

*Phrynomerus*

- 1927b, Power, p. 250; 1947, Fitzsimons, pp. 93-94;
- 1937, Hewitt, pp. 115-116; 1957, Orton, p. 83.

*Phrynomerus bifasciatus*

- \*1926a, Power, pp. 112-115; 1929, Wager, pp. 125-126;
- \*1926, Wager, pp. 170-174 (as *Rappia marmorata* = *Hyperolius marmoratus*); 1935, Fitzsimons, p. 397;
- 1926a, Noble, pp. 3-4; 1959, Schmidt and Inger, p. 190;
- 1927c, Power, p. 415; 1961, Cochran, p. 176;
- 1929, Power, pp. 475-476, 478-480; 1962, Rose, pp. 67-68.

*Phrynomerus annectens*

- 1955, Mertens, p. 32 (with reservations, possibly *P. bifasciatus* or *P. hoeschi*, i. e. *affinis*);
- \*1959, Inger, pp. 529-530; 1960a, Hoesch, p. 11.

*Phrynomerus affinis*

Undescribed.

*Ranidae**Microbatrachella**Microbatrachella capensis*

- \*1925, Hewitt, pp. 423-425; 1929, Rose, p. 40;
- 1926, Rose, p. 437; 1947, Fitzsimons, p. 45;
- 1929, Power, pp. 479-480; 1962, Rose, pp. 73-74.

*Cacosternum*

1926a, Noble, pp. 4, 8-9 (*C. boettgeri*).

*Cacosternum capense*

1926, Rose, pp. 437-438; 1930, de Villiers, p. 482;  
 1929, Rose, pp. 44-45; 1961, Cochran, p. 165;  
 †1929a, de Villiers, pp. 134-141; 1962, Rose, pp. 78-79.

*Cacosternum boettgeri*

1913, Hewitt and Power, pp. 171-172; 1937, Hewitt, pp. 105-106 (including  
 1915, Werner, pp. 375-376 (As *Arthroleptis* *C. boettgeri albiventris*);  
*schebeni*, i.e. *Cacosternum boettgeri*;— 1947, Fitzsimons, p. 49;  
*Cacosternum*, but not typical *C. boettgeri*; 1957, Balinsky, p. 383;  
 1926, Rose, p. 437; 1959, Inger, pp. 522-523  
 \*1927b, Power, pp. 250-251; 1962, Rose, p. 75.  
 1929, Power, p. 475;

*Cacosternum nanum*

Undescribed.

*Cacosternum namaquense*

Undescribed.

*Phrynobatrachus*

1924, Noble, pp. 192-193 (*P. perpalmatus*);  
 1926a, Noble, pp. 8-9 (*P. natalensis*);  
 1933, Loveridge, pp. 374-375 (? *P. acridoides*, ? *Rana mascareniensis mascareniensis*);  
 1936, Loveridge, p. 424;  
 1942, Loveridge, p. 422 (? *P. acridoides*);  
 1953, Percy, Percy and Ridley, p. 5 (*Phrynobatrachus* sp.);  
 1953, Loveridge, p. 380 (*Phrynobatrachus*, subgenus *Pararthroleptis*), p. 378 (*P. duckeri*);  
 1958, Lamotte and Dzieduszycka, pp. 1071-1086 (*P. francisci*);  
 1961, Cochran, p. 162;  
 1963, Schiøtz, pp. 46-47 (*P. calcaratus*).

*Phrynobatrachus natalensis*

\*1927a, Power, pp. 237-239; 1955, Balinsky, pp. 94-95 and 98;  
 1929, Power, p. 479; 1957, Balinsky, p. 383;  
 1937, Hewitt, pp. 101 and 103; 1961, Cochran, p. 163;  
 1947, Fitzsimons, p. 42; 1962, Wager, pp. 238-239.  
 1953, Loveridge, p. 379;

*Phrynobatrachus ukingensis*

1933, Loveridge, p. 386 (? *Arthroleptis ukingensis*);  
 1953, Loveridge, p. 380 (*P. u. ukingensis*), p. 381 (*P. u. nyikae*), pp. 382-383 (*P. u. mababiensis*);  
 1953, Percy Percy and Ridley, p. 5 (as *Arthroleptis minutus*);  
 1962, Wager, p. 240.

*Natalobatrachus**Natalobatrachus bonebergi*

1913, Hewitt and Methuen, p. 108; 1935, Power, p. 345;  
 1922, Hewitt, p. 63; 1937, Hewitt, pp. 103-104;  
 1929, Rose, p. 78; 1947, Fitzsimons, pp. 43-44;  
 †\*1931, Wager, pp. 86-91; 1952a, Wager, pp. 139-142.

*Anhydrophyrne**Anhydrophyrne rattrayi*

- \*1919, Hewitt, pp. 182-185;  
 1922, Hewitt, pp. 62-63;  
 †1922, Warren, pp. 254-262;  
 1925, Procter, pp. 909-910;  
 1926a, Noble, pp. 8-9;  
 1929, Power, pp. 479-480;  
 1929, Rose, p. 78;  
 1929c, de Villiers, pp. 482, 483, 485 and 502;  
 1937, Hewitt, p. 104;  
 1947, Fitzsimons, pp. 51 and 11;  
 1961, Cochran, p. 165;  
 1963, Wager, pp. 237-240.

*Arthroleptella**Arthroleptella lightfooti*

- 1925, Procter, pp. 909-910 (quoting personal communication of W. Rose, as *Arthroleptis*);  
 1926, Hewitt, p. 427;  
 1929, Power, pp. 479-480;  
 †\*1929, Power and Rose, pp. 114-115;  
 1929, Rose, pp. 30-33;  
 \*1929c, de Villiers, pp. 481-510;  
 1930, de Villiers, pp. 332-333;  
 1947, Fitzsimons, p. 46;  
 1959, Inger, p. 526;  
 1962b, Visser, p. 304;  
 1962, Rose, pp. 70-71.

*Arthroleptella hewitti*

Undescribed.

*Chiromantis*

- 1875, Peters, pp. 203-204 (quoting R. Buchholz verbatim, *C. rufescens* as *C. guieensis*);  
 1876, Peters, p. 714;  
 1877, Anonymous, pp. 491-492;  
 1886, Boulenger, p. 464;  
 1892, Holland, pp. 67-68;  
 1900, Wiedersheim, pp. 328 and 338;  
 1900, Sampson, pp. 689-690;  
 1901, Brandes and Schoenichen, pp. 413-416;  
 1903, Méhely, pp. 432 and 434;  
 1908, Nieden, p. 500 (*C. rufescens*);  
 1924, Noble, p. 231;  
 1925, Procter, pp. 909-910;  
 1925, Loveridge, pp. 778-779;  
 1927, de Witte, pp. 50-53;  
 1929, Ahl, pp. 32-33 (as *C. rufescens*, not *Chiromantis*, very probably *Hyperolius*);  
 1929, Power, pp. 475 and 477-478;  
 1931b, Ahl, pp. 47-48 (as *C. rufescens*, not *Chiromantis*, very probably *Hyperolius*);  
 1933, Loveridge, pp. 390 and 391-392 (*C. petersi petersi*);  
 1942, Loveridge, p. 389;  
 1942, Scortecci, pp. 7-12 (*C. petersi*), pp. 8-9 (*C. rufescens*);  
 1946, Mitchell, p. 32 (? as *Megalixalus fornasinii*), p. 33;  
 1953, Loveridge, p. 341;  
 1956, Lamotte and Vogeli, pp. 863-867 (as *Hylambates leonardi*,—*C. rufescens*);  
 1958a, Guibé and Lamotte, p. 269 (as *Hylambates leonardi*,—*C. rufescens*);  
 1958, Cherchi, pp. 167-172 (*Chiromantis petersi kelleri*);  
 1958, Verbaak, pp. 83-85;  
 1963a, Lamotte and Perret, pp. 265-276;  
 1963, Schiøtz, pp. 61-62.

*Chiromantis xerampelina*

- 1913, Hewitt and Power, p. 170;  
 1922, Hewitt, pp. 63-64 (quoting personal communication of H. Streeter);  
 †\*1926, Wager, pp. 164-169;  
 1929, Rose, pp. 77-78;  
 1931b, Ahl, pp. 62-63 (not *Chiromantis*);  
 1935, Fitzsimons, p. 392;  
 1936, Loveridge, pp. 383, 384 and caption Plate 2 fig. 1;  
 1942, Loveridge, pp. 389-390;  
 1947, Fitzsimons, pp. 64-66;  
 1950, Miller, pp. 103-104;  
 1957, Wager, pp. 29-33;  
 1958, Verbaak, pp. 83-85;  
 1961, Cochran, pp. 168 and 170 (*Chiromantis xerampolina*);  
 1962, Rose, pp. 105-106 (details from *C. rufescens* possibly included).

*Hemisus*

- 1929, Rose, p. 78;  
 1947, Fitzsimons, pp. 53-55 and 11;

*Hemisis marmoratus*

- \*1907, Bles, pp. 443-458;  
 †1929, Wager, pp. 127-135;  
 1930, de Villiers, pp. 483-485;  
 †1933, Loveridge, p. 388;  
 1935, Fitzsimons, p. 394;  
 †1936, Loveridge, p. 427;  
 1950, Miller, pp. 104 and 102;  
 1952b, Wager, pp. 349-354;  
 1958a, Guibé and Lamotte, pp. 265-266;  
 1959, Schmidt and Inger, pp. 171-174;  
 1960a, Wager, p. 26;  
 1961, Cochran, p. 165;  
 1963, Schiøtz, pp. 50-51.

*Hemisis guttatum*

- \*1958b, Wager, pp. 201-205;  
 1960a, Wager, p. 26.

*Arthroleptis*

- 1898, Brauer, pp. 89-94 (as *Arthroleptis seychellensis*. Genus *Sooglossus* Boulenger later created for this species);  
 1900, Wiedersheim, pp. 307-308, 339 (*Arthroleptis seychellensis*, = *Sooglossus*);  
 1901, Brandes and Schoenichen, pp. 452-456 (*Arthroleptis seychellensis*, = *Sooglossus*);  
 1906b, Boulenger, pp. 320-321 (*Sooglossus seychellensis*);  
 1953, Loveridge, p. 380 (*Arthroleptis*), p. 384 (*A. xenodactyloides*), p. 386 (*A. boulengeri*);  
 1958b, Guibé and Lamotte, pp. 125-133 (*A. cruscum*);  
 1961, Cochran, p. 162;  
 1963b, Lamotte and Perret, pp. 277-284 (*A. poecilonotus*).

*Arthroleptis wahlbergi*

- †1935, Power, p. 336;  
 †1937, Hewitt, p. 104;  
 1947, Fitzsimons, p. 47;  
 †1950a, Wager, pp. 69-71.

*Arthroleptis stenodactylus*

- 1938, Mertens, p. 15;  
 1953, Loveridge, p. 390;  
 1957, Loveridge, p. 352 footnote 273.

*Arthroleptis xenodactyloides*

Undescribed.

*Strongylopus*

The species here grouped under genus *Strongylopus* are usually referred to the genus *Rana*, the generic name *Strongylopus*, applied by Tschudi to *Strongylopus fasciatus*, not having found support although it was applied by Steindachner to *Strongylopus grayi* (Smith). There do not appear to be any species of *Strongylopus* of which the tadpoles have been described, other than those known from Southern Africa.

*Strongylopus fasciatus*

- 1926, Rose, p. 434;  
 1929, Rose, p. 18;  
 \*1937, Hewitt, pp. 96-97;  
 1947, Fitzsimons, p. 34;  
 1957, Balinsky, p. 383.

*Strongylopus grayi*

- 1910, Werner, p. 297;  
 1913, Hewitt and Power, p. 168;  
 1926, Rose, pp. 433, 444-445 and  
 Corrigenda p. 450;  
 1929, Rose, pp. 13-16;  
 1929a, de Villiers, pp. 123-129;  
 \*1937, Hewitt, pp. 97-99 (N.B. footnote p. 98);  
 1947, Fitzsimons, p. 33;  
 1959, Inger, p. 519;  
 1961, Cochran, p. 162.

*Strongylopus wageri*

- †1961b, Wager, pp. 151-155.

*Strongylopus hymenopus*

Undescribed.

*Rana* (*R. fuscigula* and *R. angolensis*)

1918c, Boulenger, pp. 136-137;

1947, Fitzsimons, p. 30.

*Rana fuscigula*

\*1910, Werner, pp. 295-296;  
 1913, Hewitt and Power, p. 167;  
 †1918c, Boulenger, p. 136;  
 1926, Rose, p. 434;  
 \*1927a, Power, pp. 239-242;  
 1929, Rose, p. 19;

1937, Hewitt, p. 95 and Addendum Part 2  
 addendum for p. 95;  
 1953, Loveridge, pp. 366-367;  
 †1959, Inger, pp. 516-517, 519.  
 1961, Cochran, pp. 162-163.

*Rana angolensis*

†1918c, Boulenger, p. 136;  
 1933, Loveridge, p. 365;  
 1936, Loveridge, p. 411;

1937, Hewitt, pp. 94-95;  
 1953, Loveridge, pp. 365-366;  
 1957, Balinsky, p. 383.

*Rana umbraculata* (as *R. vertebralis*)

\*1927, Hewitt, pp. 406-407;  
 1948, Fitzsimons, p. 78;

1959, Inger, pp. 515-516.

*Rana vertebralis*

Undescribed.

*Ptychadena*

1898, Werner, p. 193 (*P. aequiplicata* as *Rana mascareniensis* var. *aequiplicata*);  
 1940, Mertens, p. 114 (*P. aequiplicata*);  
 1958a, Guibé and Lamotte, pp. 254 (*P. maccarthyensis*), 258-259 (*P. mascareniensis*) and 259-260 (*P. submascareniensis*);  
 1958b, Lamotte, Dzieduszycka and Lauwarier, pp. 1464-1482 (1464-1472 *P. submascareniensis*, 1472-1477 *P. tournieri* and 1478-1482 *P. trinodis*);  
 1959, Lamotte, Perret and Dzieduszycka, pp. 1346-1350 (*P. taenioscelis*);  
 1961a, Lamotte and Perret, pp. 192-210 (192-197 *P. maccarthyensis*, 197-201 *P. perreti*, and 201-210 *P. mascareniensis*).

*Ptychadena anchietae*

\*1927a, Power, pp. 242-245 (as *R. oxyrhynchus*); 1935, Power, pp. 334-335 (as *R. oxyrhynchus*).  
 1927c, Power, p. 411 (as *R. oxyrhynchus*);

*Ptychadena oxyrhynchus*

\*1935, Power, pp. 334-335;  
 1937, Hewitt, pp. 100-101;

1947, Fitzsimons, p. 32;  
 1958a, Guibé and Lamotte, pp. 255-257.

*Ptychadena taenioscelis*

\*1959, Lamotte, Perret and Dzieduszycka, pp. 1346-1350.

*Ptychadena mascareniensis*

\*1889, Héron-Royer and van Bambeke, pp. 187 and 252-255;  
 1933, Loveridge, pp. 374-375 (? *Rana m. mascareniensis*, ? *Phrynobatrachus acridoides*);  
 1933, Flower, p. 845;  
 1936, Parker, pp. 139-140;

1938, Mertens, pp. 12-13 (*P. mascareniensis venusta*);  
 1953, Percy, Percy and Ridley, p. 5 (as *Rana sp.*,—  
 ? *P. mascareniensis*);  
 \*1958a, Guibé and Lamotte, pp. 258-259;  
 \*1961a, Lamotte and Perret, pp. 201-210.

*Ptychadena subpunctata* (synonyms *P. porosissima* and *P. chobiensis*, vide Loveridge, 1953, p. 372).

Undescribed.

### *Hylarana*

#### *(Hylarana albolabris)*

1888, Boettger, pp. 94 and 95-96;  
1931a, Ahl, pp. 52-53 (as *Hyperolius picturatus*, see Schiøtz);  
1931b, Ahl, pp. 333-334 (as *Hyperolius picturatus*, see Schiøtz);  
1938, Mertens, pp. 14 and 33;

1940, Mertens, p. 115;  
1957, Lamotte, Lauwarier and Perret, pp. 1312-1327;  
1958a, Guibé and Lamotte, pp. 249-251;  
1960a, Mertens, p. 342;  
1963, Schiøtz, p. 30.

#### *Hylarana galamenis*

1933, Loveridge, pp. 359, 366 (? *R. galamensis*, ? *Pyxicephalus adspersus*);  
1937, Andersson, p. 23.

#### *Hylarana darlingi*

1956, Laurent, pp. 229-230;

### *Hildebrandtia*

#### *Hildebrandtia ornata*

1896, Boulenger, p. 22 (as *Rana ornata*—not *Hylarana*);  
\*1959, Schmidt and Inger, pp. 40-41 (*H. ornata moeruensis*).

### *Pyxicephalus (Tomopterna and Pyxicephalus)*

1933, Scortecci, pp. 18, 20-21, 70 (*P. cimmarutai*); 1957, Balinsky, p. 383.

#### *Tomopterna delalandei*

1910, Werner, p. 298;  
1913, Hewitt and Power, pp. 169-170;  
1914, Methuen and Hewitt, p. 124;  
1926, Rose, p. 434;  
\*1927b, Power, pp. 251-252;  
1927c, Power, pp. 412-413;

1929, Power, p. 474;  
1929, Rose, p. 23;  
1937, Hewitt, p. 92;  
1947, Fitzsimons, p. 39;  
1959, Inger, pp. 520 and 519;  
1960a, Hoesch, pp. 11 and 16.

#### *Tomopterna marmorata*

Undescribed.

#### *Tomopterna natalensis*

†1937, Hewitt, pp. 93-94; 1947, Fitzsimons, p. 40.

#### *Pyxicephalus adspersus*

1910, Werner, pp. 298-299 (as ? *Pyxicephalus adspersus*—not *Pyxicephalus*);  
1911, Hewitt, p. 53;  
\*1927b, Power, pp. 252 and 254;  
1927c, Power, pp. 411-412;  
1929, Power, p. 474;  
1929, Rose, p. 72;  
1933, Loveridge, pp. 359, 366 (? *Pyxicephalus adspersus*, ? *Rana galamensis*);

1937, Hewitt, pp. 90-91;  
1947, Fitzsimons, p. 38;  
1950, Loveridge, p. 254;  
1950, Miller, pp. 100-102;  
1954, Balinsky and Balinsky, pp. 55-58;  
1955, Balinsky, pp. 94-99;  
1956, Rose, p. 257;  
1957, Wager, p. 170;  
1960a, Hoesch, pp. 11 and 15-16.

### *Leptopelis*

1906, Boulenger, p. 179 (*L. brevirostris*);  
1924, Noble, p. 244 (*L. brevirostris*);  
1926b, Noble, pp. 134-135 (*L. brevirostris*);

- 1929, Power, pp. 477-478 (*L. brevirostris*);  
 1938, Mertens, pp. 8, 23-24 (*L. aubryi*), and pp. 31-32 and 33 (*Leptopelis* ?);  
 1940, Mertens, p. 130 (*L. calcaratus*);  
 1940, Scortecchi, (*L. gramineus*);  
 1951, Bellens, pp. 83-91 (*L. karissimbensis*);  
 1957, Loveridge, p. 316 footnote 199 (*L. gramineus*);  
 1958a, Guibé and Lamotte, pp. 266-267 (as *Chiromantis rufescens*, subsequently referred to *Hylambates leonardi* = *Leptopelis* ?). Not *Chiromantis*, not *Hylambates*;  
 1958b, Perret, p. 266 (*L. notatus*) and p. 274 (*L. brevirostris*);  
 1959, Lamotte, Perret and Dzieduszycka, pp. 1341-1346 (*L. notatus*);  
 1959, Schmidt and Inger, (*L. bocagei*);  
 1960b, Mertens, p. 60 (*L. karissimbensis*);  
 1961, Cochran, p. 170 (*L. brevirostris* as *Hylambates brevirostris*);  
 1961b, Lamotte and Perret, pp. 855-885 (*L. aubryi*, *L. viridis*, *L. anchiaetae*, *L. ocellatus*, *L. calcaratus*);  
 1963, Schiøtz, pp. 83-86 (*L. aubryi*).

### *Leptopelis natalensis*

- |                              |                            |
|------------------------------|----------------------------|
| †1931, Wager, pp. 79-91;     | 1950b, Wager, pp. 249-251; |
| 1935, Power, p. 337;         | 1960a, Wager, pp. 26-27;   |
| 1937, Hewitt, p. 115;        | 1961, Cochran, p. 170.     |
| 1947, Fitzsimons, pp. 67-69; |                            |

### *Leptopelis concolor*

Undescribed.

### *Leptopelis xenodactylus*

Undescribed (unless it is a subspecies of *L. bocagei*).

## *Hyperolius*

- 1931a, Ahl, p. 42 (as *H. punctatissimus*—not *Hyperolius*),  
 pp. 52-53 (as *H. picturatus*—not *Hyperolius*, see *Hylarana*),  
 pp. 55-56 (as *H. parallelus*—not *Hyperolius*),  
 pp. 110-111 (as *H. narinus*—not *Hyperolius*),  
 p. 91 (spawn assigned to *H. obstetricans*—association doubtful);  
 1931b, Ahl, p. 300 (as *H. punctatissimus*—not *Hyperolius*),  
 p. 318 (as *H. parallelus*—not *Hyperolius*),  
 pp. 333-334 (as *H. picturatus*—not *Hyperolius*, see *Hylarana*);  
 p. 384 (as *H. narinus*—not *Hyperolius*),  
 pp. 364-365 (spawn assigned to *H. obstetricans*—association doubtful);  
 1933, Loveridge, p. 408 (*H. marginatus*, i.e. *H. marmoratus marginatus*),  
 pp. 412 and 413 (*H. parkeri*);  
 1936, Ahl, pp. 282-283 (*H. aylmeri*);  
 1936, Loveridge, pp. 400 and 401 (*H. vermicularis*),  
 p. 401 (*H. sansibaricus* = *H. tuberilinguis*);  
 1937, Hewitt, p. 99;  
 1938, Mertens, pp. 27-28 (*H. concolor*);  
 1940, Mertens, p. 124 (*H. kohleri* and *H. kuligae*);  
 1942, Loveridge, p. 409 (*H. citrinus citrinus*, ? = *Hyperolius marmoratus*);  
 1958, Arnould and Lamotte, pp. 573-586 (*H. zonatus* and *H. lamottei*);  
 1963c, Lamotte and Perret, pp. 545-558 (*H. hieroglyphycus*, *H. steindachneri pardalis*, *H. acutirostris*,  
*H. viridiflavus*, *H. tuberculatus*);  
 1963, Schiøtz, pp. 62-66.

### *Hyperolius pusillus*

- |                                                        |                            |
|--------------------------------------------------------|----------------------------|
| *1935, Power, pp. 339-342 (as <i>H. translucens</i> ); | 1947, Fitzsimons, p. 76;   |
| 1937, Hewitt, pp. 111-112;                             | 1955b, Wager, pp. 119-122. |

### *Hyperolius nasutus*

Undescribed.

*Hyperolius marmoratus*

- 1929, Wager, p. 127;  
 1933, Loveridge, p. 408 (as *H. marginatus*, i.e. = *H. marmoratus marginatus*);  
 \*1935, Power, pp. 337-339 (*H. marmoratus verrucosus* as *H. marmoratus pondoensis*);  
 1937, Hewitt, pp. 110-111;  
 1942, Loveridge, p. 409 (as *H. citrinus citrinus*, ? = *H. marmoratus*);  
 1947, Fitzsimons, p. 75 (*H. marmoratus verrucosus*);  
 1953, Loveridge, p. 354 (*H. marmoratus albofasciatus* breeding data);  
 1955d, Wager, pp. 293-297 (*H. marmoratus marmoratus*);  
 1958a, Wager, pp. 55-57 (*H. marmoratus verrucosus*).

*Hyperolius horstockii*

- 1926, Rose, p. 450; 1959, Inger, p. 528;  
 †1929, Power and Rose, pp. 112-113; 1961, Visser, p. 244;  
 1947, Fitzsimons, p. 74; 1961, Cochran, pp. 167-168.

*Hyperolius semidiscus*

- 1937, Hewitt, p. 112; †1956a, Wager, pp. 150-152.

*Hyperolius puncticulatus*

Undescribed.

*Hyperolius tuberilinguis*

- 1937, Loveridge, p. 401 (as *H. sansibaricus*); †1955c, Wager, pp. 237-240.

*Afrixalus*

- 1924, Noble, p. 271 (*Megalixalus spinosus*);  
 1937, Andersson, p. 24 (as *Hylambates cassinoides*—not *Hylambates* but *Afrixalus*, *A. fulvovittatus* according to Schiøtz);  
 1938, Mertens, pp. 24-25 (*Megalixalus dorsalis*), pp. 7-8, 25-26, 50 (*Megalixalus laevis*);  
 1947, Fitzsimons, pp. 70-71;  
 1956, Lamotte and Vogeli, pp. 867-872 (*A. leptosomus fulvovittatus* and *A. dorsalis*);  
 1958a, Guibé and Lamotte, pp. 271-272 (*A. dorsalis* and *A. fulvovittatus fulvovittatus*);  
 1963, Schiøtz, pp. 51-54 (*A. dorsalis dorsalis*), and p. 64 (*Afrixalus*);

*Afrixalus brachycnemis knysnae*

- 1929, Rose, p. 78 (as *Megalixalus spinifrons*, ? actually *A. brachycnemis knysnae*);  
 \*1935, Power, pp. 342-345 (as *M. fornasinii spinifrons*);  
 1937, Hewitt, p. 113 (as *M. fornasinii*);  
 1959, Inger, pp. 527-528 (as *A. spinifrons*).

*Afrixalus brachycnemis brachycnemis*

Undescribed.

*Afrixalus spinifrons*

- 1922, Hewitt, p. 63 (quoting P. Boneberg— 1956c, Wager, pp. 319-323;  
 ? *A. spinifrons* ? *A. b. knysnae*);  
 \*1960a, Wager, pp. 25-26.

*Afrixalus fornasinii*

- 1931b, Ahl, p. 443 (as *Megalixalus fornasinii*—not *Afrixalus*, very probably *Hyperolius*);  
 \*1938, Mertens, pp. 24-25 (as *Hyperolius dorsalis*, i.e. ? *A. fornasinii conigicus*);  
 1946, Mitchell, p. 32 (as *M. fornasinii*, presumably *Chiromantis*);  
 1953, Loveridge, p. 345;  
 1956, Lamotte and Vogeli, pp. 871-872 (*A. dorsalis*, i.e. ? *A. fornasinii conigicus*);  
 1958a, Guibé and Lamotte, pp. 271-272 (*A. dorsalis*, i.e. ? *A. fornasinii conigicus*);  
 1960a, Wager, pp. 25-26;  
 1963, Schiøtz, pp. 51-54 (*A. dorsalis dorsalis*, i.e. ? *A. fornasinii conigicus*).



*Hylambates* (includes *Kassina*)

- 1898, Werner, p. 197 (as *Hylambates rufus*, ? with doubt—not *Hylambates*);  
 1929, Power, p. 478;  
 1930, Parker, p. 4 (as ? *Leptopelis bocagii*);  
 1931, Wager, p. 84 (quoting personal communication of Hewitt); 1933, Scortecci, pp. 49-50, 70 (= *H. somalica*);  
 1937, Andersson, p. 24 (as *Hylambates cassinoides*—not *Hylambates* but *Afrixalus*, *A. fulvovittatus* according to Schiøtz);  
 1938, Mertens, p. 32;  
 1942, Hoffman, pp. 144-147;  
 1947, Fitzsimons, pp. 80-82;  
 1956, Lamotte and Vogeli, pp. 872-876 (as *Kassina senegalensis*—*K. decorata*, see Schiøtz);  
 1958a, Guibé and Lamotte, p. 270 (as *Kassina senegalensis*—*K. decorata*, see above);  
 1958a, Perret, p. 1443;  
 1963, Schiøtz, pp. 81-82.

*Hylambates senegalensis*

- |                                              |                                       |
|----------------------------------------------|---------------------------------------|
| *1926a, Power, pp. 107-111;                  | 1942, Hoffman, pp. 144-147;           |
| 1926b, Power, pp. 427-428;                   | 1947, Fitzsimons, pp. 80-81;          |
| 1926a, Noble, pp. 2-3;                       | 1957, Balinsky, p. 383;               |
| 1929, Power, p. 475;                         | 1959, Inger, p. 527;                  |
| 1935, Power, p. 336;                         | 1959, Schmidt and Inger, pp. 184-185; |
| 1935, Fitzsimons, p. 393;                    | 1960a, Wager, pp. 26-27;              |
| 1937, Andersson, pp. 24-27 (possibly in fact | 1961a, Wager, pp. 35-38;              |
| <i>H. cassinoides</i> , see Schiøtz);        | 1961, Cochran, p. 168;                |
| 1937, Hewitt, pp. 106-109;                   | 1962, Rose, p. 66.                    |

*Hylambates wealei*

- |                                             |                            |
|---------------------------------------------|----------------------------|
| †1926, Rose, pp. 435-436 and Corrigenda and | 1937, Hewitt, pp. 106-108; |
| Addenda p. 450;                             | 1942, Hoffman, 145-147;    |
| †1927c, Power, p. 414;                      | 1959, Inger, p. 527;       |
| 1929, Rose, pp. 35-37;                      | 1962, Rose, p. 65.         |
| 1935, Power, p. 337;                        |                            |

*Hylambates maculatus*

- |                                      |                            |
|--------------------------------------|----------------------------|
| *1926a, Noble, pp. 2-3;              | 1956b, Wager, pp. 229-234; |
| 1931b, Ahl, pp. 456-457;             | 1960a, Wager, pp. 26-27.   |
| 1931, Wager, p. 84 (quoting personal |                            |
| communication of Hewitt);            |                            |

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 ———— 1931b. Anura III (Polypedatidae). *Tierreich* **55**: 475 pp.  
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